

FINAL SUBMISSION
INCREMENTS D,E,F

**STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT**

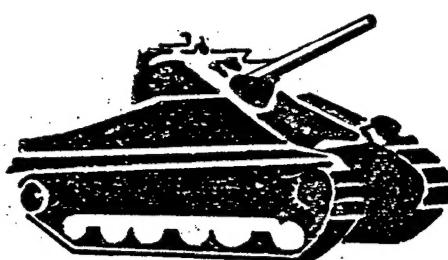
EXECUTIVE SUMMARY

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**ENERGY
ENGINEERING
ANALYSIS**

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prepared for:

DEPARTMENT OF THE ARMY
NORFOLK DISTRICT
CORPS OF ENGINEERS
Project Management Branch (NAOEN-MA)

prepared by:

STV/Seelye Stevenson Value & Knecht
ENGINEERS AND PLANNERS
99 Park Avenue
New York, N.Y. 10016
(212) 867-4000

CONTRACT NO. : DACA65-81-C-0024

DECEMBER 1983

in association with:

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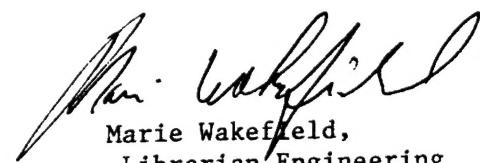


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ENERGY ENGINEERING ANALYSIS PROGRAM
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

FINAL SUBMISSION INCREMENTS D, E, F

EXECUTIVE SUMMARY

PREPARED FOR

U. S. ARMY CORPS OF ENGINEERS
NORFOLK DISTRICT

UNDER
CONTRACT NO. DACA65-81-C-0024

PREPARED BY

SEELYE STEVENSON VALUE & KNECHT
An STV Engineers Professional Firm
New York, NY 10016

DECEMBER 1983



STV/SEELYE STEVENSON VALUE & KNECHT.

ENGINEERS & PLANNERS.
99 PARK AVENUE
NEW YORK, NY, 10016
212/867-4000, Telex 64 9081 SSV&K

December 22, 1983

Department of the Army
Norfolk District - Corps of Engineers
803 Front Street
Norfolk, Virginia 23510

Attention: NAOEN-MA/Gerald Barnes

Reference: Energy Engineering Analysis Program (EEAP)
Stratford Army Engine Plant (SAEP)
Stratford, Connecticut

Subject: Final Submission
Increments D, E, F

Contract No.: DACA65-81-C-0024

SSV&K Project No.: 24-4184-02

Dear Mr. Barnes:

Enclosed please find one (1) set of the Final Submission of Increments D, E, F for the Stratford Army Engine Plant at Stratford, Connecticut. This submission consists of the following components:

- o Executive Summary
- o Main Report
- o Increment F
- o Appendix
- o Project Programming Documents

In addition to being separately bound, the Executive Summary and Increment F are included within the Main Report.

All comments from the Prefinal Submission have been reviewed and incorporated as appropriate. The Prefinal Submission review comments are in the Appendix-Section G. Selected correspondence, including Minutes of Meetings, are in the Appendix Section A.

The assistance that was provided by AVCO-LYCOMING Division and Corps of Engineers personnel proved invaluable in completing this assignment. Their cooperation is greatly appreciated.

Thank you for this opportunity to be of service.

Very truly yours,

STV/SEELYE STEVENSON VALUE & KNECHT

Alfred Klein, P.E.
Vice President

STV/SEELYE STEVENSON VALUE & KNECHT.

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AGENCY

Department of the Army Norfolk District - Corps of Engineers 803 Front Street Norfolk, Virginia 23510 Attention: NAOEN-MA/Gerald Barnes	1	New York District - Corps of Engineers 26 Federal Plaza New York, New York 10278 Attention: NANEN-MA/Chester Yee	1
Department of the Army Huntsville Division - Corps of Engineers P.O. Box 1600 Hunstville, Alabama 35807 Attention: HNDED-PM/W.R. Peterson	2		
WESTON INC. Weston Way West Chester, Pennsylvania 19380	1		
AVCO-LYCOMING DIVISION 550 South Main Street Stratford, Connecticut 06494 Attention: Plant Engineering/Robert Carr	2		
Commander - DARCOM 5001 Eisenhower Avenue Alexandria, Virginia 22333 Attention: DRCIS-E	1		
Department of the Army - AVSCOM 4300 Goodfellow Blve. St. Louis, Misouri 63120 Attention: DRSAV-PEC/Ron Mateuzzi	2		
Department of the Army DARCOM-I&SA Rock Island, Illinois 61299 Attention: DRICS-RI-IU/D.H. Ekstrom	1		
Department of the Army North Atlantic Division - Corps of Engineers 90 Church Street New York, New York 10007 Attention: NEDEN-TM/Bill Norwin	1		
LTC Gray DCRB-GTCP 550 South Main Street Stratford, Connecticut 06497	1		

ENERGY ENGINEERING ANALYSIS PROGRAM
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

FINAL SUBMISSION - INCREMENTS D, E, F

EXECUTIVE SUMMARY

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LIST OF ABBREVIATIONS

acfm	Actual Cubic Feet Per Minute
AECP	Annual Energy Consumption Program
AFEP	Army Facilities Energy Plan
APEC	Automated Procedures for Engineering Consultants
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
Ave	Avenue
BECP	Building Energy Consumption Program
Bldg	Building
BOD	Beneficial Occupancy Date
BSC	Building Selection Code
BTU	British Thermal Unit
BTUH	British Thermal Unit Per Hour
°C	Degree Centigrade
CCC	Current Construction Cost
CCF	One Hundred Cubic Feet
Cp	Specific Heat
CCU	Central Control Unit
CF	Cubic Foot
CFM	Cubic Foot Per Minute
CLT	Communications Link Termination
CMU	Concrete Masonry Unit
COE	Corps of Engineers
CW	Cold Water
DARCOM	Department of the Army Readiness Command
DD	Degree Days
DOD	Department of Defense
DTM	Data Transmission Medium
ECAM	Energy Conservation and Management Program
ECM	Energy Conservation Measure
ECR	Energy-to-Cost Ratio
EMCS	Energy Monitoring and Control System
EPA	Environmental Protection Agency
°F	Degree Fahrenheit
FID	Field Interface Device
Fluor.	Fluorescent
Ft	Foot
FY	Fiscal Year

LIST OF ABBREVIATIONS (Cont'd)

Gal	Gallon
Goco	Government Owned-Contractor Operated
GPM	Gallons Per Minute
GBTU	Giga BTU - 10^9 BTU = 1 Billion BTU
GSF	Gross Square Feet
HE	Heat Exchanger
Horiz	Horizontal
HP	Horsepower
HPS	High Pressure Sodium
Hr	Hour
HTW	High Temperature Hot Water
HVAC	Heating, Ventilating, and Air Conditioning
HW	Hot Water
In	Inch
INCAND	Incandescent
I/O	Input/Output
KBH	Kilo BTU Per Hour
KBTU	Kilo British Thermal Unit ($KBTU = 10^3$ BTU)
KGSF	Kilo Gross Square Feet ($KGSF = 10^3$ GSF)
KV	KiloVolt
KVA	KiloVolt Amp
Kw	Kilowatt
Kwh	Kilowatt Hour
L	Lumen
lbs	Pounds
MBTU	Mega British Thermal Unit ($MBTU = 10^6$ BTU)
MCR	Main Control Room
Min	Minute
Mon	Months
MTW	Medium Temperature Hot Water
MUX	Multiplexer
MV	Mercury Vapor
NAC	Nitric Acid Concentractor
NC	Normally Closed
NO	Normally Open
P	Permanent Building
PDB	Project Development Brochure
ppm	Parts Per Million
psi	Pounds Per Square Inch (Absolute)
psig	Pounds Per Square Inch (Gate)

LIST OF ABBREVIATIONS (Cont'd)

Q	Heat Per Unit of Time (BTUH's)
Qty	Quantity
RDF	Refuse Derived Fuels
SAP	Simple Amortization Period
SC	Series Connected
SCFM	Standard Cubic Feet Per Minute
SIOH	Supervision, Inspection, and Overhead
SIR	Savings to Investment Ratio
SF	Square Foot
Sq	Square
T ₁	Final Temperature
T ₂	Initial Temperature
T	Temperature
TIC	Total Installed Cost
TPD	Tons Per Day
TW	Tempered Water
W	Watts
WC	Water Column
WDW	Window
Wk	Week
WSF	Window Square Foot Area
Yr	Year

DEFINITION OF TERMS

BENEFICIAL OCCUPANCY DATE (BOD)

The date a facility begins to operate.

COST INDEX

Comparison of Energy cost Indices for various years giving a chosen base year a value of 100.

CURRENT CONSTRUCTION COST (CCC)

The project installation cost in the year the project was analyzed. Installation costs are non-recurring and include all labor and material. Also taken into account are location, taxes, contractor costs, bond, and SIOH. Design costs are not included and must be added to the CCC to develop the total installed cost (TIC).

DARCOM GOAL

The target figure for energy consumption in KBTU/GSF-YR. Using FY75 as the base year, basewide energy consumption must be reduced by 20% by the end of FY85. The goals were established to enable the ARMY to achieve energy conservation requirements assigned by Executive order 12003 and by the Department of Defense. In addition, the Army Facility Energy Plan dated February 24, 1978, established a long term goal for a 50 percent reduction in facility energy usage by the year 2000.

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

Military funded program for retrofitting existing DOD facilities to make them more energy efficient.

ENERGY CONSERVATION MEASURES (ECM)

Programs to conserve energy and/or costs through energy/manpower reductions.

ENERGY COST

Cost of Source Energy Consumed (obtained from utility bills).

ENERGY COST INDEX

Energy cost per square foot of building.

DEFINITION OF TERMS (Cont'd)

ENERGY MONITORING AND CONTROL SYSTEM (EMCS)

This is a computer-based control system used to achieve energy dollar savings through automatic control of building heating, ventilating and air conditioning (HVAC) systems. This includes implementation of various energy conservation measures, such as programmed equipment shutoff, programmed outside air shutoff, and equipment optimization, to reduce the total energy consumption of individual buildings, reduce energy distribution system losses and improve HVAC system capability.

ENERGY-TO-COST RATIO (ECR)

Annual energy savings (MBTU/YR) divided by the construction cost (\$1,000).

ELECTRICAL COST INDEX

Electricity cost comparison for various years using a base year with an assigned value of 100.

ELECTRICITY INDEX

Comparison of Electrical Energy Indices for various years to a chosen base year.

FUELS ENERGY INDEX

Ratio of BTU's of fuel consumed to the square footage of the base.

HEATING DEGREE DAYS

Total number of degree days based on 65°F.

HIGH TEMPERATURE HOT WATER (HTW)

A hot water heat transfer system generally using water above 350°F.

MEDIUM TEMPERATURE HOT WATER (MTW)

A hot water heat transfer system generally using water between 230°F and 350°F.

DEFINITIONS OF TERMS (Cont'd)

SAVINGS TO INVESTMENT RATIO (SIR)

Energy Conservation Investment Program (ECIP) Life Cycle Cost Economic Analysis Criterion. The Savings to Investment Ratio is the lifetime dollar savings of a project divided by the total investment (including construction cost, design supervision, inspection and overhead). For a project to qualify for ECIP funding, the SIR must be at least 1.0.

SIMPLE AMORTIZATION PERIOD (SAP)

The project capital investment divided by the yearly savings. This yields the period of time required to recover the initial capital investment.

SOURCE ELECTRICITY ENERGY

Total amount of electricity purchased or total amount produced before line and efficiency losses.

SOURCE ENERGY CONSUMED

Sum of fuels consumed and electricity used (includes all fuels such as heating oil, diesel fuel, natural gas, propane, coal, etc.).

SOURCE ENERGY INDEX

Ratio of BTU's source energy consumed to square footage of the base.

SOURCE INDEX

Comparison of the Source Energy Indices for various years giving a chosen base year a value of 100.

STANDBY STATUS

Active or laid-away buildings or equipment used to maintain the plant at a reduced production level in readiness for mobilization.

TOTAL INSTALLED COST (TIC)

The sum of the CCC and the design costs.

1.0 Introduction

This Energy Engineering Analysis; covering Increments D, E and F; contains technical and economic analyses for cogeneration, central boiler plant coal conversion, engine test cell heat recovery, waste oil recovery, package boiler for summer use and Facilities Engineer conservation measures. This report is a supplement to previous work by SSV&K involving buildings, utilities and energy distribution systems which was accomplished under Increments A, B and G.

1.1 Purpose of Study

The purpose of this analysis is to develop a systematic program of projects that will result in energy consumption reductions in compliance with the stated goals of the Army Facilities Energy Plan.

- A. Reduce Army installation and active energy consumption by 25% of that consumed in FY75 as the base year.
- B. Reduce average annual energy consumption per gross square foot of floor area by 20% in existing facilities compared to FY75 as the base year. At least 12% of the energy consumption reduced in existing buildings shall be accomplished through energy conservation projects under the Energy Conservation Investment Program (ECIP).
- C. Reduce average annual energy consumption per gross square foot of floor area by 45% in new buildings compared to FY75 as the base year.
- D. Reduce dependence on critical fuels. The DOD goals to reduce dependence on critical fuels are:
 - (1) To obtain at least 10% of total Army installation energy from coal, coal gasification, solid waste, refuse derived fuel and biomass.
 - (2) To equip all natural gas only heating units and plants over 5 MEGA BTU per hour output with the capability to use oil or other alternate fuels (1982 goal).
 - (3) To have on hand at the beginning of each heating season a 30-day fuel supply for all oil only, oil - natural gas, and coal heating units over 5 mega BTU per hour output based upon the coldest month recorded and in a mobilization condition.

In order to achieve these goals, the following will be incorporated:

- o applicable data and results of related past and current studies

- o a coordinated Energy Engineering Analysis of the base
- o Project Development Brochures (PDB's), Military Construction Project Data (DD Forms 1391), and supporting documentation for feasible Energy Conservation Investment Program (ECIP) projects
- o practical and economically feasible energy conservation methods
- o a listing of recommended ECIP projects in SIR order

1.2 Authority for Study

This Energy Engineering Analysis was undertaken and this Report was prepared under Contract No. DACA65-81-C-0024 issued by the Department of the Army, Norfolk District, Corps of Engineers, to Seelye Stevenson Value & Knecht.

1.3 Scope of Work

The scope of work for this Energy Engineering Analysis is defined in "DAEN-MPE-E SCOPE OF WORK FOR ENERGY ENGINEERING ANALYSIS PROGRAM" dated January 22, 1982. This document has been reproduced and is in the Appendix Section B.

Economic analyses are performed in accordance with "DAEN-MPO-U ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) GUIDANCE" dated August 10, 1982.

1.4 Increments of Work

1.4.1 Increment D

Increment D projects involve determining the feasibility of new co generation and solid waste plants utilizing solid fuels supplemented, if feasible, with refuse derived fuels (RDF) and waste oil fuels. The primary objective is to reduce energy consumption through the capture and reuse of energy presently being wasted.

Solid waste and RDF plants are not part of this contract. Refer to Detailed Scope of Work and DACA65-81-C-0024 supplementary contract of July 1982 for further details. The Scope of Work is in the Appendix- Section B.

1.4.2 Increment E

Increment E projects involve determining the feasibility of constructing central boiler plants to supply steam or high temperature hot water, as applicable, to all or discrete parts of the base.

1.4.3 Increment F

Increment F projects involve recommending modifications and changes in system operation which are within the Facilities Engineer funding authority and management control. Other areas under Increment F include determining any energy-related areas of operation requiring additional training of Facilities Engineering personnel and describing expendable equipment which should be changed to a higher efficiency type at its next replacement.

2.0 SITE DESCRIPTION, HISTORY AND ENERGY DISTRIBUTION SYSTEMS

2.1 Site Description

The Stratford Army Engine Plant (SAEP) is a government owned, contractor operated, military - industrial installation. Avco Lycoming, the contractor-operator, does research, testing and production of gas turbine engines.

The plant is in Stratford, Connecticut (See Figures 2.1.1-1 and 2.1.1-2). It lies on Connecticut's southern shore approximately 55 miles northeast of New York City.

The site is bounded by the Housatonic River on the north, Main Street on the southwest and, Sniffen Lane to the southeast (See Figure 2.1.1-3). The facility consists of 48 individual buildings with a total area of 1,577,639 square feet. (See Table 2.1.1.)

2.2. Plant History

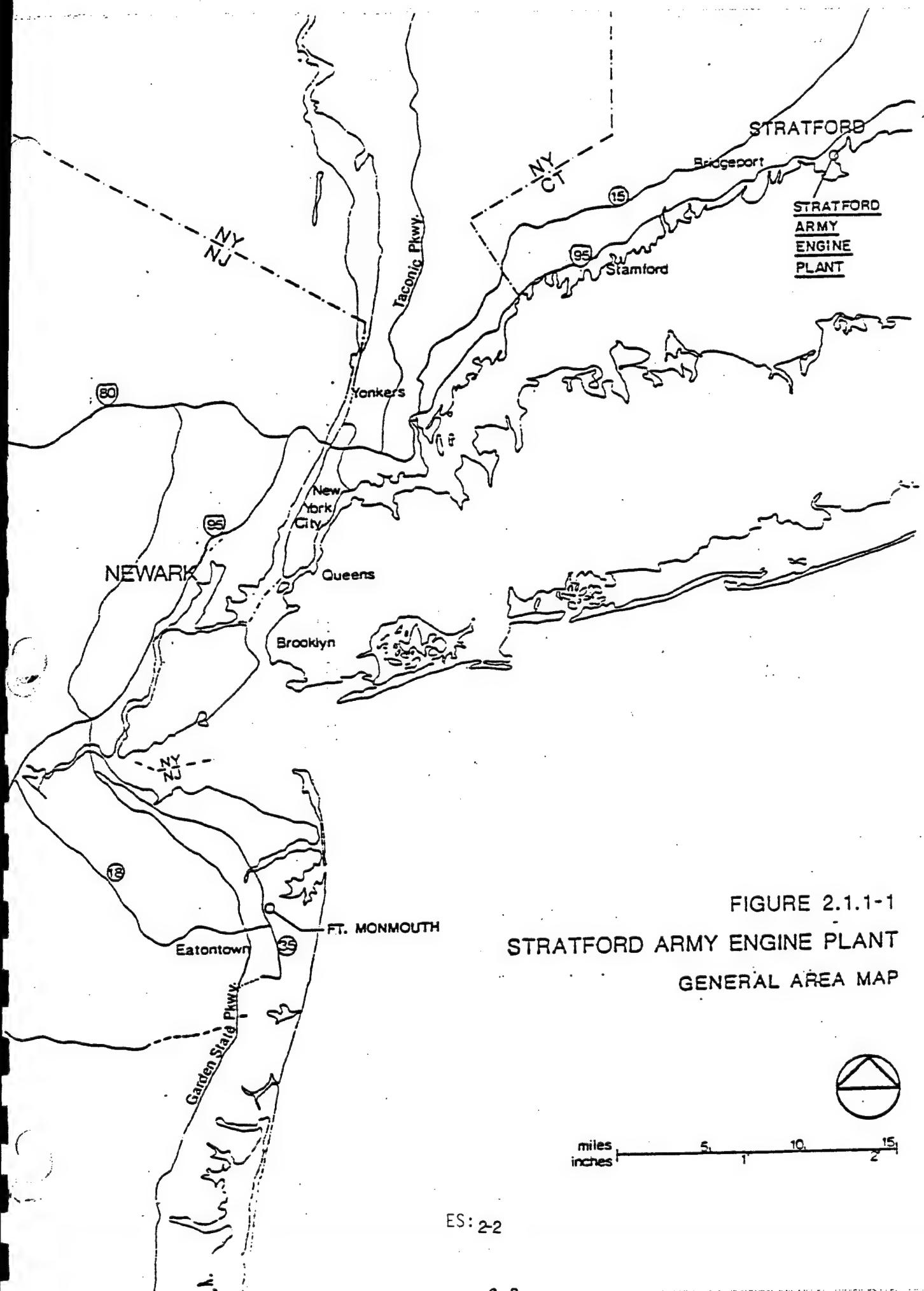
The history of the Stratford Army Engine Plant is closely tied to the history of aviation. The site was developed in 1929 by Igor Sikorsky for the production of flying boats. During the initial development of the site, Buildings 1, 2, 3, 3A and 10 were constructed.

In 1939, the Chance Voight Company merged with Sikorsky to manufacture the 'King Fisher' observation plane. In 1942, the United States War Department contracted with the Chance Voight Company for the production of the Corsair aircraft. This program required the construction of additional buildings and extensions to existing buildings.

With the end of the war, the Chance Voight Company had a reduction in Government contracts which led to the de-activation of the Stratford Plant between the years 1948 and 1951.

In 1951, the Chance Voight Company was acquired by AVCO LYCOMING. At this time the U.S. Air Force contracted Avco Lycoming to manufacture the R-1820 radial engine and major components of the J-47 jet aircraft engine under a license agreement. This agreement also transferred control of the Stratford Plant to the Air Force and allowed Avco Lycoming to operate the site. Major renovations and additions occurred during this reactivation of the Plant.

Over the years, Avco Lycoming increased its contractual work with the government and expanded to serve the private sector. In 1954, the government contracted Avco Lycoming to develop and manufacture the T-53 and T-55 engines whose chief application would be in helicopters and aircraft. In the late 1960's, Avco Lycoming upgraded their T-53 and T-55 engines to suit commercial and international markets. In 1976, they manufactured the 'Super TF'



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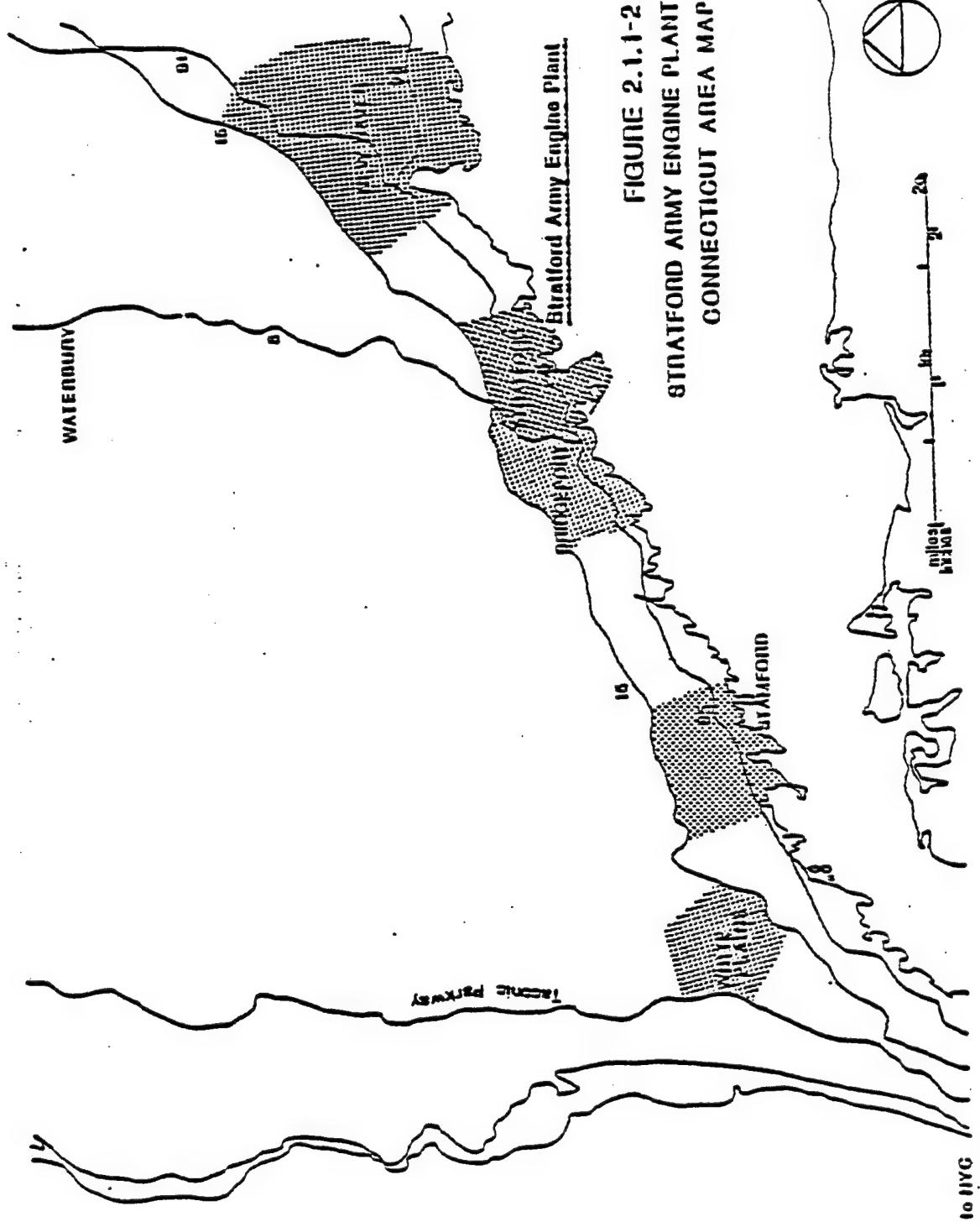


FIGURE 2.1.1-2
STRATFORD ARMY ENGINE PLANT
CONNECTICUT AREA MAP

FIGURE 2.1.1-3
STRATFORD ARAY ENGINE PLANT
GENERAL SITE MAP

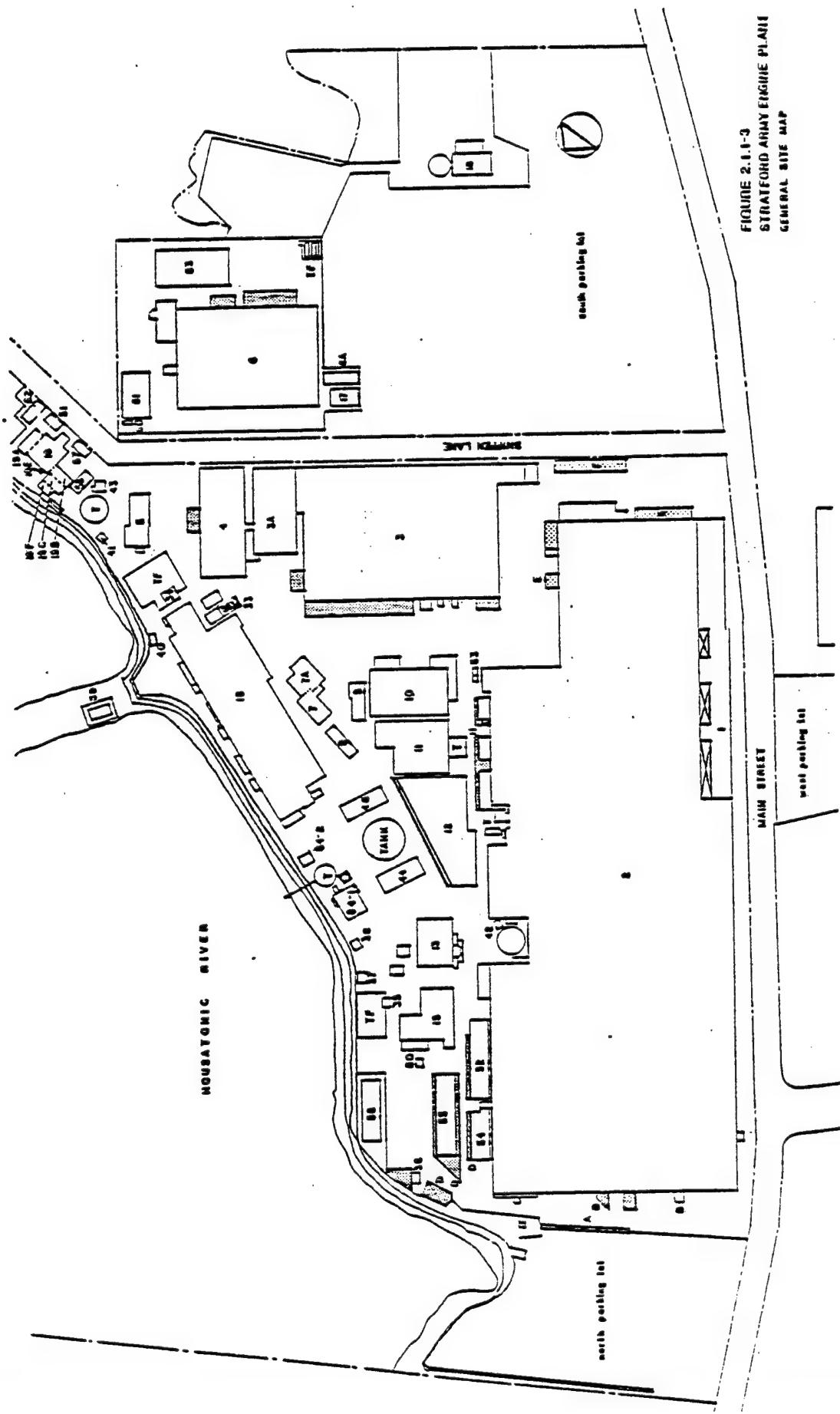


TABLE 2.1.1

MISSISSA BUILDING LIST

BLDG NO.	DESCRIPTION	AREA (sq. ft.)	VAL. CONSTL.
1	MAIN ADMINISTRATIVE & GOVERNMENT OFFICES	88,606	29-63
2	FNUO. HIC. OPERATIONS, PLANT STCIN & COMPUTER GENERATING STATION	843,572	29-44
3	HIC. STCIN & DEVELOPMENT MATERIALS OPERATIONS	240,565	30-44
4	ENGINEERING MATERIALS LABORATORY & ACCURRING INSPECTION	16,815	10-44
5	EXPERIMENTAL PROCESS & MATERIALS SIGNALS	24,000	45
6	INDUSTRIAL ENGINE FUEL SYSTEM DEVELOPMENT ILSI	5,471	44
7	INDUSTRIAL ENVIRONMENTAL PROCESS & MATERIALS SIGNALS	87,079	44
8	INDUSTRIAL ENGINE MECHANICAL COMPONENT ILSI	2,130	44
9	INDUSTRIAL ENGINE MECHANICAL COMPONENT ILSI	6,786	42
10	HIC. TANK ENG. ENGINE COMPONENTS & ASSMBLY (RECONFIGURATION LHS)	1,829	42
11	GENERAL STORAGE	2,474	42
12	MATERIAL MAINTENANCE SHOP	19,302	29
13	SCRAP & MATERIAL RECYCLATION PROCESSING	22,010	40
14	LUBRICATION & GENERAL PURPOSE STORAGE	21,840	41
15	PRODUCTION DEVELOPMENT-ILSI CELLS & SUPPLYING SERVICES	10,816	43
16	PRODUCTION DEVELOPMENT-ILSI CELLS & SUPPLYING SERVICES	15,529	53
17	COMPONENTS ILSI STCIN GENERATING PLANT	2,400	52
18	PLANT CIVIL/HYDRAULIC PLATING WASTE INCINERATOR	3,600	58
19	HURDING ENGINE COMPRESSOR & POWER HYDRAULIC COMPONENT ILSI	9,190	44-45
20	CODING ADHAR PUMPING STATION	616	53
21	BEST FUEL - TRANSFER & VALVE STATION	834	53
22	VALVE & TRANSFER & VALVE STATION FOR LUBRICATING & FUELING OIL BANK IN	340	53
23	STORM DRAIN PUMPING STATIONS	367	53
24	STORM DRAIN PUMPING STATIONS	367	53
25	STORM DRAIN PUMPING STATIONS	367	53
26	SPRINKLER HOUSE IN PUMPING STATION FOR 400,000 GAL. STCIN, IANK	410	44
27	SPRINKLER HOUSE IN PUMPING STATION FOR 300,000 GAL. STCIN, IANK	484	44
28	SIGNS, TOWERING & EQUIPMENT WAREHOUSING	4,000	44
29	STAIRS, TOWERING & EQUIPMENT WAREHOUSING	4,250	44
30	COMPRESSION & VACUUM PUMP-DE-VILOP COMP. ILSI	744	58
31	PRODUCTION MATERIAL WAREHOUSING	6,080	62
32	SUPPLIES EQUIPMENT PURCHISING	12,800	61
33	PRODUCT FABN MATERIAL WAREHOUSE	4,440	63
34	PRODUCT FABN MATERIAL WAREHOUSE	7,200	43
35	PRODUCTION MATERIAL WAREHOUSE	1,212	43
36	HIGH PRESSURE COMPRESSOR ILSI IAN.	0,000	44
37	TRANSFORMER STATION ILSI FACILITY (19 COMPLEX)	5,540	47
38	MISSISSA ASSMBLY & ILSI LABORATORY	1,084	44
39	MISSISSA SIGNAGE MAGAZINE H.S.D.	250	68
40	HIGH PRESSURE NATURAL GAS PUMPING STATION Avg/Yearly	6,300	69
41	REFUGIATION PLANT (LOW RPM. SYSTEM)	1,000	71
42	HIGH PRESSURE AIR SYSTEMS	211	58
43	INDUSTRIAL WASTE INCINERATOR SYSTEM PUMPING STATION	614	75
44-1	IND. A SIC. WASTE INCIN. PLANT (UNLOAD IN.)	210	75
44-2	IND. A SIC. WASTE INCIN. PLANT (PUMP IN.)	614	75

series of marine and industrial engines that are included in compressor sets, pump sets, generator sets, off-road vehicles and railroad engines. Avco Lycoming's recent projects include the development and manufacture of a new 1500 shaft horsepower gas turbine engine for battle tanks.

In 1976, the U.S. Army Corps of Engineers acquired the Stratford Army Engine Plant from the U.S. Air Force. At this point the plant became a Government Owned Contractor Operated (GOCO) facility with Avco Lycoming as tenant.

2.3 Description of Energy Distribution Systems

2.3.1 Steam

Steam for heating is produced in the central boiler plant in Building No. 2. The system heats the entire plant except for several small buildings with self-contained heating systems. The steam and condensate return systems run partly above and partly below ground.

The steam distribution system has an operating pressure of 100 psig, is insulated, and is well maintained.

The present condensate return system is in poor condition resulting in a loss of condensate return. This reflects in a loss of energy, waste of water, and a more than normal requirement of water treatment. The following conditions exist:

- o Missing motors and pumps that have been removed over the years and not replaced.
- o Direct dumping of the condensate into sewer lines.
- o Improper pitch and changes in elevation of condensate lines which may possibly result in sediment accumulation, rusting of pipes and sticking check valves.
- o Most of the underground lines are in an unsatisfactory condition, with clogged lines and a backing up of condensate to the point where check valves stay closed and receivers overflow.
- o Many of the condensate return lines are uninsulated resulting in a loss of energy.

The condensate return system is scheduled for replacement. The new system, when installed, will efficiently conserve energy.

2.3.2 Natural Gas

Natural gas which is used for Boiler fuel in Building No. 2 is supplied on an interruptible basis by the Southern Connecticut Gas

Company. Gas which is used for process heating is supplied and separately metered on a firm contract basis by the same utility company. All piping and equipment is in satisfactory condition.

2.3.3 Central Boiler Plant

2.3.3.1 General

The central boiler plant, fired by both No. 6 Fuel Oil and Interruptible Natural Gas, operates 24 hours per day, 365 days per year. It supplies energy in the form of steam for heating and processes. There are three package boilers which have a total capacity of 180,000 pounds of steam per hour with a minimum output capacity of 8,000 pounds of steam per hour.

2.3.3.2 Description of Existing Central Heating Plant

The central boiler plant is located on the east side of Building No. 2. The boiler plant consists of three water tube "D" type steam boilers built by the Bigelow Boiler Co. in 1970 and put on line in 1972. Each boiler package is equipped with stub stacks and a pressurized furnace that delivers 60,000 pounds of steam per hour at an operating pressure of 100 psi and a maximum working pressure rating of 225 psi.

The dual burners are of the steam atomizing type burning both No. 6 oil and natural gas. Also included is a windbox, register, gas pilot and electric ignition.

The forced draft is accomplished by dual drive fans mounted on the wind box. Air flow is controlled by an inlet damper that is actuated by a signal from the air/fuel ratio controller.

The boiler plant has two duplex type, No. 6 oil pump and heater sets. The duplex oil pumps on each set are of the rotary type and the two heaters are of the tubular heat exchanger type that utilizes steam from the boilers as the heating medium. The steam condensate from the heat exchanger is wasted by going into the sewer at 110°F, in order to prevent contamination from possible oil leaks.

Present heat recovery equipment consists of an economizer on boiler No. 1. The two remaining boilers, Nos. 2 and 3, are not equipped with any heat recovery devices.

The economizer installed on boiler No. 1 is not being used due to malfunction.

The feed water system has three pumps. One is a dual drive type (electric & steam turbine) 40 HP pump and two are electrical drive pumps 20 HP and 40 HP each.

There is a recently installed deaerator capable of maintaining 0.005 C.C. of oxygen per liter in effluent that heats the feed water to 220°F.

The surge tank consists of a receiver that handles the condensate return from the entire facility. It is equipped with pumps to transfer the condensate return and make-up water to the deaerator.

Zeolite water softeners are used for the pretreatment of make-up water. In addition, each boiler has a chemical feed system that injects chemicals directly into the steam drum.

2.3.3.3 Instrumentation

Instrumentation and controls are as follows:

Hagan (Westinghouse) pneumatic semi-automatic non-recycling metering type control, consisting of a master pressure controller for gas/air and oil/air ratio control. Indicators consist of gas, oil and atomizer steam pressure gages. There is also a three point draft gage used to monitor the windbox, the furnace and the stack pressure. For permanent records they utilize a steam flow and stack temperature recorder.

The feed water has a two element control. Both steam flow and drum level are utilized to position the control valve. This control valve is a Fisher air operated model.

2.3.3.4 Condition of Existing System

The major pieces of equipment such as boilers, boiler feed system, deaerator, surge tank, transfer pumps, oil heating and pump sets, water softeners and chemical feed units, are in good condition.

Boiler feed pumps are presently being replaced by new higher efficiency types. The original installation consisted of one 40 HP dual driven pump (steam turbine and electric motor) and one 40 HP electric motor pump. To date a new 20 HP electrically driven low net positive suction head (NPSH) pump has been installed. In the near future two more 20 HP electrically driven pumps and one 20 HP steam driven pump will be installed to replace the existing 40 HP electrically driven and the dual drive motors.

Tests were performed by Associated Control Equipment Service, Inc., of Stamford, Connecticut on February 21, 1983 on Boilers 2 and 3. Boiler 1 was on standby at the time. The boiler plant description and findings can be found in Appendix Section C. The test results indicate, even with Boilers running on low loads, a Boiler efficiency of 79.2 percent for Boiler 2 and 80.1 percent for Boiler 3.

The economizer on Boiler 1 is malfunctioning and therefore not in use. The installation of economizers in Boilers 2 and 3 and the upgrading of the economizer on Boiler 1 would increase boiler efficiency and is a recommended project.

The addition of O₂ trim on all boilers will also increase boiler efficiency. A savings of 3 percent of No. 6 fuel oil can be realized. This project is recommended.

See Appendix - Section C for back-up calculations.

2.3.4 Cooling Systems

There is no central chilled water plant for the facility. Office areas are cooled by window and roof-top direct expansion units.

3.0 Installation Energy Profile

3.1 General

Energy used at SAE includes No. 2, No. 4 and No. 6 fuel oil, natural gas under both firm and interruptible contracts, electricity, diesel fuel, jet fuel and propane.

Firm contract natural gas, jet fuel, diesel fuel and propane are utilized for process-related functions.

Electricity has multiple uses. Building uses include motors for fans, pumps and air conditioning compressors as well as domestic hot water generation. Process uses include but are not limited to machine tools, electric furnaces, welders and conveyors.

No. 6 fuel and interruptible natural gas are used to generate steam in the central boiler plant in Building 2. Steam is used for space heating, boiler room auxiliaries, domestic hot water and process equipment. No. 2 fuel oil is used for testing diesel tank engines. No. 4 fuel oil is used for the high pressure steam boilers in Building 17.

3.2 Population

3.2.1 Present Population

The following is a breakdown of base personnel. The figures were supplied by Ayco-Lycoming, Division of Timekeeping and Labor Distribution in August 1982.

<u>Direct (Production)</u>	<u>Total</u>
Engineering	936
Manufacturing	1,374
Quality Assurance	456
Information and System Service	145
TOTAL.....	<u>2,952</u>
	2,911

<u>Indirect (Support)</u>	<u>Total</u>
General Manager	5
Business Strategies	17
Commercial Engine Program	10
Engineering	233
Manufacturing	1,291
Quality Assurance	191
Finance	186
Marketing and Production Support	66
Personnel	98
Information Systems and Service	148
Military Engine Programs	<u>30</u>
	TOTAL.....2,275
Total Personnel	5,207

The plant is at present in full operation with a full complement of personnel. See Figure 3-5 for historical trend at the SAEP.

3.3 Historical Energy Consumption

3.3.1 General

The historical energy profile for SAEP is based on annual energy use from FY75 through FY81. Fuel records obtained from SAEP are in Appendix, Section D.

3.3.2 Tabular Information

Table 3.3.2 entitled "ANNUAL ENERGY CONSUMPTION," shows historical annual energy use from FY75 through FY81 for Total Source Energy and each of the individual energy sources discussed in Section 3.1. The sum of No. 6 fuel oil and interruptible natural gas is also indicated in Table 3.3.2. This quantity is a measure of the fuel input to the central boiler plant. For compilation of fuel consumption data, see Appendix, Section D.

Table 3.3.2 indicates the following information for each fuel:

- o Consumption (Base Unit) - CCF/YR is the base unit for natural gas, KWH/YR for electricity, and GAL/YR for fuel oil, diesel fuel, jet fuel and propane.
- o Consumption in MBTU/YR.
- o Unit Consumption in KBTU/GSF-YR - Energy consumption in 1,000 BTU (KBTU) divided by the Gross Square Foot Area of the Plant.
- o Unit Consumption per Degree Day.

ANNUAL ENERGY CONSUMPTION
TABLE 3.3.2

PARAMETER	UNIT	FY75	FY76	FY77	FY78	FY79	FY80	FY81
GROSS AREA	GSF	1,560,764	1,560,764	1,560,764	1,560,764	1,560,764	1,560,764	1,560,764
DEGREE DAYS, HEATING	DD	5,293	5,066	5,783	5,821	5,268	5,405	5,797
TOTAL SOURCE ENERGY:								
CONSUMPTION	MBTU/YR	1,154,036	1,027,993	1,081,529	1,074,607	1,166,916	1,223,545	1,238,359
UNIT CONSUMPTION	KBTU/GSF/YR	739	659	693	689	748	790	793
DARCOM GOAL	KBTU/GSF/YR	739	724	709	695	680	665	650
UNIT CONSUMPTION / DD	BTU/GSF/DD/YR	140	130	120	118	142	146	112
ENERGY INDEX, REF. FY75								
COST	DOLLARS/YR	3,157,071	2,839,360	3,270,257	3,183,905	4,138,622	6,446,916	8,465,164
UNIT COST	DOLLARS/KGSF/YR	2,023	1,919	2,095	2,040	2,652	4,130	5,424
COST INDEX, REF. FY75								
NO. 6 FUEL OIL PLUS								
INTERRUPTIBLE GAS:								
CONSUMPTION	MBTU/YR	430,549	344,368	351,742	360,257	333,743	336,524	300,417
UNIT CONSUMPTION	KBTU/GSF/YR	275.9	220.6	225.4	224.4	213.8	215.6	192.5
UNIT CONSUMPTION/DD		52.11	43.55	38.9	38.55	40.59	39.89	33.20
ENERGY INDEX, REF. FY75								
COST	DOLLARS/YR	100	80	82	81	77	78	70
UNIT COST	DOLLARS/KGSF/YR	876,563	600,034	770,382	808,488	919,205	1,302,758	1,577,556
COST INDEX, REF. FY75	NONE	561.6	435.7	493.6	518.0	588.9	885.9	1,010.8

ANNUAL ENERGY CONSUMPTION (CONT'D.)

TABLE 3-3.2

PARAMETER	UNIT	FY75				FY76				FY77				FY78				FY79				FY80				FY81									
		FY75	FY76	FY77	FY78	FY75	FY76	FY77	FY78	FY75	FY76	FY77	FY78	FY75	FY76	FY77	FY78	FY75	FY76	FY77	FY78	FY75	FY76	FY77	FY78	FY75	FY76	FY77	FY78						
NO. 2 FUEL OIL																																			
CONSUMPTION	MBTU/YR	725	546	835	773	708	660	666	660	660	660	660	666	666	666	666	666	666	666	666	666	666	666	666	666	666	666	666	666	666					
UNIT CONSUMPTION	KBTU/GSF/YR	0.46	0.35	0.53	0.50	0.45	0.42	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23				
UNIT CONSUMPTION/DD	BTU/GSF/DO/YR	0.09	0.07	0.09	0.09	0.09	0.09	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04				
ENERGY INDEX, REF. FY75	NONE	100	71	108	100	92	86	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35				
COST	DOLLARS/YR	1,643	1,221	2,205	2,452	2,616	4,319	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986	2,986			
UNIT COST	DOLLARS/KGSF/YR	1.05	0.78	1.46	1.57	1.68	2.77	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91			
COST INDEX, REF. FY75	NONE	100	74	139	149	159	263	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182			
CONSUMPTION	GALLONS	5,227	3,937	6,020	5,573	5,105	4,758	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639	2,639			
NO. 4 FUEL OIL																																			
CONSUMPTION	MBTU/YR	4,136	4,296	3,549	1,740	--	--	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770	3,770			
UNIT CONSUMPTION	KBTU/GSF/YR	2.65	2.75	2.27	1.11	--	--	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42		
UNIT CONSUMPTION/DD	BTU/GSF/DO/YR	0.50	0.54	0.39	0.19	--	--	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45		
ENERGY INDEX, REF. FY75	NONE	100	104	86	42	--	--	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91				
COST	DOLLARS/YR	10,109	10,074	9,065	4,360	--	--	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500			
UNIT COST	DOLLARS/KGSF/YR	6.48	6.45	5.81	2.79	--	--	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13	13.13			
COST INDEX, REF. FY75	NONE	100	100	90	43	--	--	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203		
CONSUMPTION	GALLONS	29,300	30,500	25,200	12,300	--	--	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700		
NO. 6 FUEL OIL																																			
CONSUMPTION	MBTU/YR	243,847	120,597	254,793	223,274	235,584	235,584	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427	141,427			
UNIT CONSUMPTION	KBTU/GSF/YR	156.24	77.27	163.25	143.05	150.94	150.94	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61	90.61			
UNIT CONSUMPTION/DD	BTU/GSF/DO/YR	29.52	15.25	28.23	24.58	28.65	3.2	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6		
ENERGY INDEX, REF. FY75	NONE	100	49	104	95	97	97	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58			
COST	DOLLARS/YR	551,148	263,029	551,697	512,005	509,502	139,341	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031	856,031		
UNIT COST	DOLLARS/KGSF/YR	363.13	169.04	353.48	328.05	377.75	69.28	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47	540.47		
COST INDEX, REF. FY75	NONE	100	48	100	93	107	25	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155	155
CONSUMPTION	GALLONS	1,693,000	837,000	1,769,000	1,551,000	1,636,000	187,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000	982,000		

ANNUAL ENERGY CONSUMPTION (CONT'D.)

TABLE 3.3.2

PARAMETER	UNIT	FY75	FY76	FY77	FY78	FY79	FY80	FY81
INTERMITTENT GAS								
CONSUMPTION	CCF/YR	1,067,020	2,237,710	969,490	1,269,830	981,590	3,095,510	1,589,900
CONSUMPTION	MBTU/YR	166,702	223,771	96,349	126,983	98,159	309,551	158,990
CONSUMPTION	KBTU/GSF/YR	119.6	143.4	62.1	81.4	62.9	198.3	101.9
UNIT CONSUMPTION/00								
ENERGY INDEX, REF. FY75	NONE	100	120	52	68	53	166	85
COST	DOLLARS/YR	325,415	416,205	218,605	296,493	329,623	1,243,417	721,525
UNIT COST	DOLLARS/KGSF/YR	208.5	266.7	140.1	190.0	211.2	797.7	462.3
COST INDEX, REF. FY75	NONE	100	120	67	91	101	302	222
FIRM GAS								
CONSUMPTION	CCF/YR	291,810	293,800	274,540	275,790	451,345	329,997	221,314
CONSUMPTION	MBTU/YR	29,181	29,300	27,454	27,579	45,135	32,997	22,131
CONSUMPTION	KBTU/GSF/YR	10.7	18.8	17.6	17.7	28.9	21.1	14.2
UNIT CONSUMPTION								
ENERGY INDEX, REF. FY75	NONE	100	101	94	95	155	113	76
COST	DOLLARS/YR	72,561	92,762	100,061	99,618	144,080	147,383	117,347
UNIT COST	DOLLARS/KGSF/YR	46.5	59.4	64.1	63.6	92.0	94.4	75.2
COST INDEX, REF. FY75	NONE	100	128	138	137	200	203	162
ELECTRICITY								
CONSUMPTION	KWH/YR	42,835,000	39,562,000	41,313,000	44,668,000	49,932,422	52,751,067	53,965,564
CONSUMPTION	MBTU/YR	496,886	450,919	479,231	510,149	579,216	611,912	626,001
CONSUMPTION	KBTU/GSF/YR	318.4	294.0	307.0	332.0	371.1	392.1	401.1
UNIT CONSUMPTION								
ENERGY INDEX, REF. FY75	NONE	100	92	96	104	117	123	126
COST	DOLLARS/YR	1,567,929	1,352,729	1,606,019	1,636,969	2,790,585	3,389,763	4,433,430
UNIT COST	DOLLARS/KGSF/YR	966.1	866.7	1,029.0	1,048.8	1,467.6	2,171.9	2,840.6
COST INDEX	REF. FY75	100	90	107	109	152	225	294
OPTIONAL	KWH/YR	123,336	115,160	118,992	119,400	131,520	137,800	134,090

ANNUAL ENERGY CONSUMPTION (CONT'D.)

TABLE 3.3.2

PARAMETER	UNIT	FY75	FY76	FY77	FY78	FY79	FY80	FY81
PROPANE CONSUMPTION	GAL/YR	--	--	17,225	25,707	30,373	27,089	23,669
CONSUMPTION	MBTU/YR	--	--	1,576	2,352	2,779	2,479	2,166
UNIT CONSUMPTION	KBTU/GSF/YR	--	--	1.0	1.5	1.8	1.6	1.4
ENERGY INDEX, REF. FY75	NONE	--	--	*	*	*	*	*
COST	DOLLARS/YR	--	--	7,349	14,144	18,095	18,123	19,020
UNIT COST	DOLLARS/KGSF/YR	--	--	4.7	9.1	11.6	11.6	12.2
COST INDEX, REF. FY75	NONE	--	--	*	*	*	*	*
DIESEL FUEL CONSUMPTION	MBTU/YR	12,186	23,321	17,699	23,644	35,923	49,686	57,671
UNIT CONSUMPTION	KBTU/GSF/YR	7.8	14.9	11.3	15.1	23.0	31.0	36.9
ENERGY INDEX, REF. FY75	NONE	100	191	145	194	295	408	473
COST	DOLLARS/YR	26,641	54,792	45,725	63,259	129,415	270,858	419,518
UNIT COST	DOLLARS/KGSF/YR	17.1	35.1	29.3	40.5	82.9	173.5	268.8
COST INDEX, REF. FY75	NONE	100	206	172	237	406	1,017	1,575
JET FUEL CONSUMPTION	MBTU/YR	180,374	167,162	199,443	150,113	169,412	195,518	226,707
UNIT CONSUMPTION	KBTU/GSF/YR	115.6	107.1	127.8	96.2	103.5	125.27	145.25
ENERGY INDEX, REF. FY75	NONE	100	93	111	83	92	139	126
COST	DOLLARS/YR	658,021	641,694	729,167	552,828	642,300	1,219,102	1,804,802
UNIT COST	DOLLARS/KGSF/YR	421.6	411.1	467.2	354.2	411.5	781	1,207
COST INDEX, REF. FY75	NONE	100	98	111	84	98	185	286

* PROPANE WAS NOT USED DURING FY75 THEREFORE IS NO ENERGY OR COST INDEX, REF FY75

- o Energy Index, Ref FY75 - Ratio of energy consumption in any year as compared to base year FY75. The value of Energy Index for FY75 is 100.
- o Cost in Dollars per Year.
- o Unit Cost in Dollars per 1,000 GSF per year.
- o Cost Index, Ref FY75. Ratio of cost in any year to the base year of FY75. The value of the index for FY75 is 100.
- o DARCOM Goal - The target figure for energy consumption in KBTU/GSF-YR. Using FY75 as the base year, basewide energy consumption must be reduced by 20% by the end of FY85. The goals were established to enable the ARMY to achieve energy conservation requirements assigned by Executive Order 12003 and by the Department of Defense. In addition, the Army Facility Energy Plan dated February 24, 1978, established by a long term goal for a 50 percent reduction in facility energy usage by the year 2000.

3.3.3 Graphic Information

Figures 3-1 to 3-7 indicate the historical energy consumption profile at SAEF. Total source energy, interruptible natural gas, electricity and No. 6 fuel oil are plotted month by month for the Base Year (FY75) and the last three available years (FY79, FY80 and FY81). These fuels are also plotted on a year by year basis throughout the period FY75 through FY81. Jet fuel and diesel fuel consumption are graphically displayed for FY75 through FY81.

Figures 3-1, 3-2, 3-3 and 3-4 show the expected degree of correlation between heating degree days and fuel input (electricity, No. 6 fuel oil and interruptible natural gas) to the central boiler plant.

Figure 3-5 indicates electricity, firm contract gas, and personnel employed from FY75 through FY81. Employment increases from FY76 as does electricity. Firm gas consumption also rises with the exception of a slight decline in the last two years.

Figure 3-6 shows the No. 6 fuel oil/interruptible natural gas combination against heating degree days and the DARCOM goal. The boiler fuel line follows a downward slope paralleling the DARCOM goal.

Figure 3-7 indicates the two process fuels (jet fuel and diesel fuel) consumed at the Plant from FY75 to FY81.

FIGURE 3-1

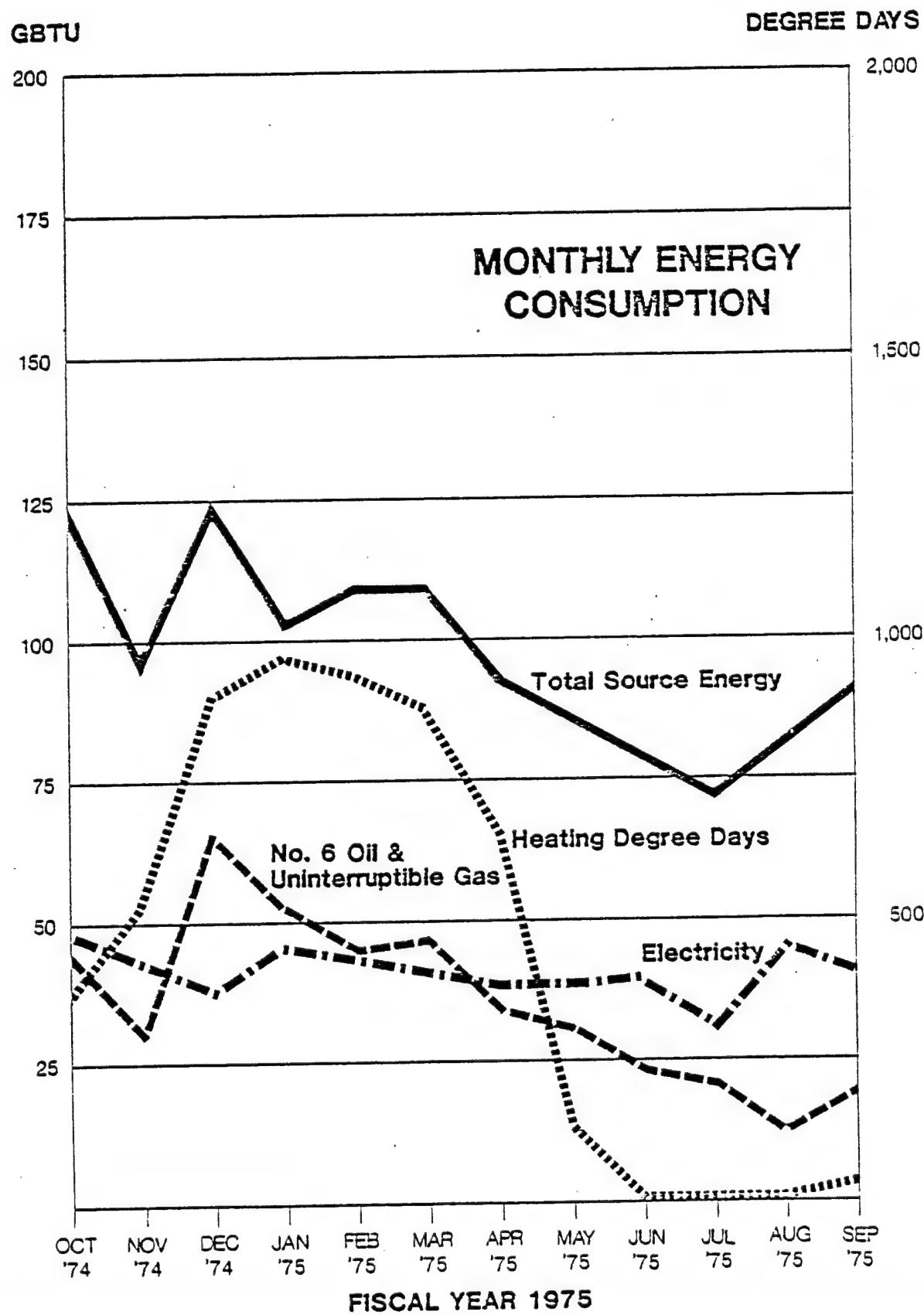


FIGURE 3 - 2

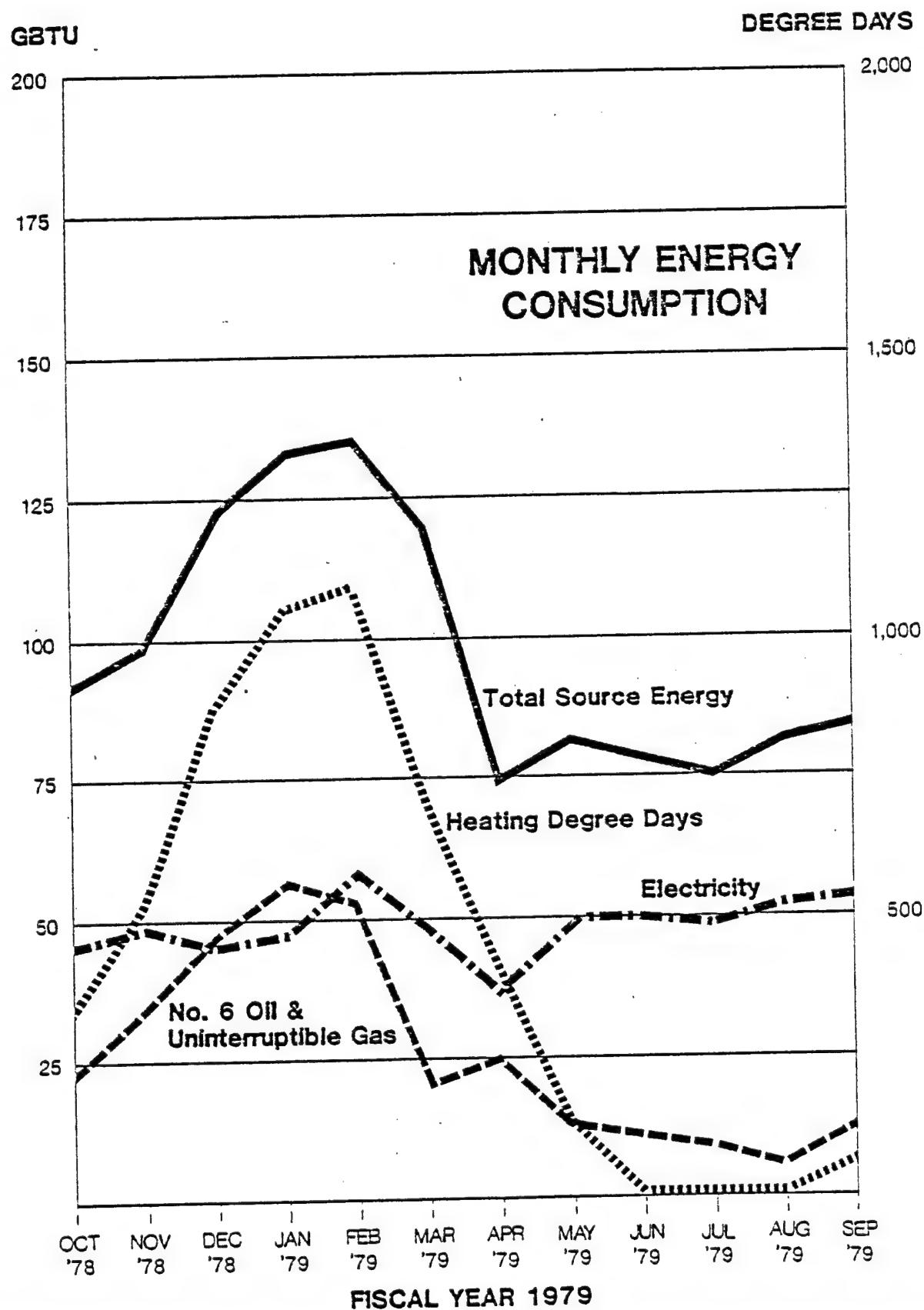


FIGURE 3-3

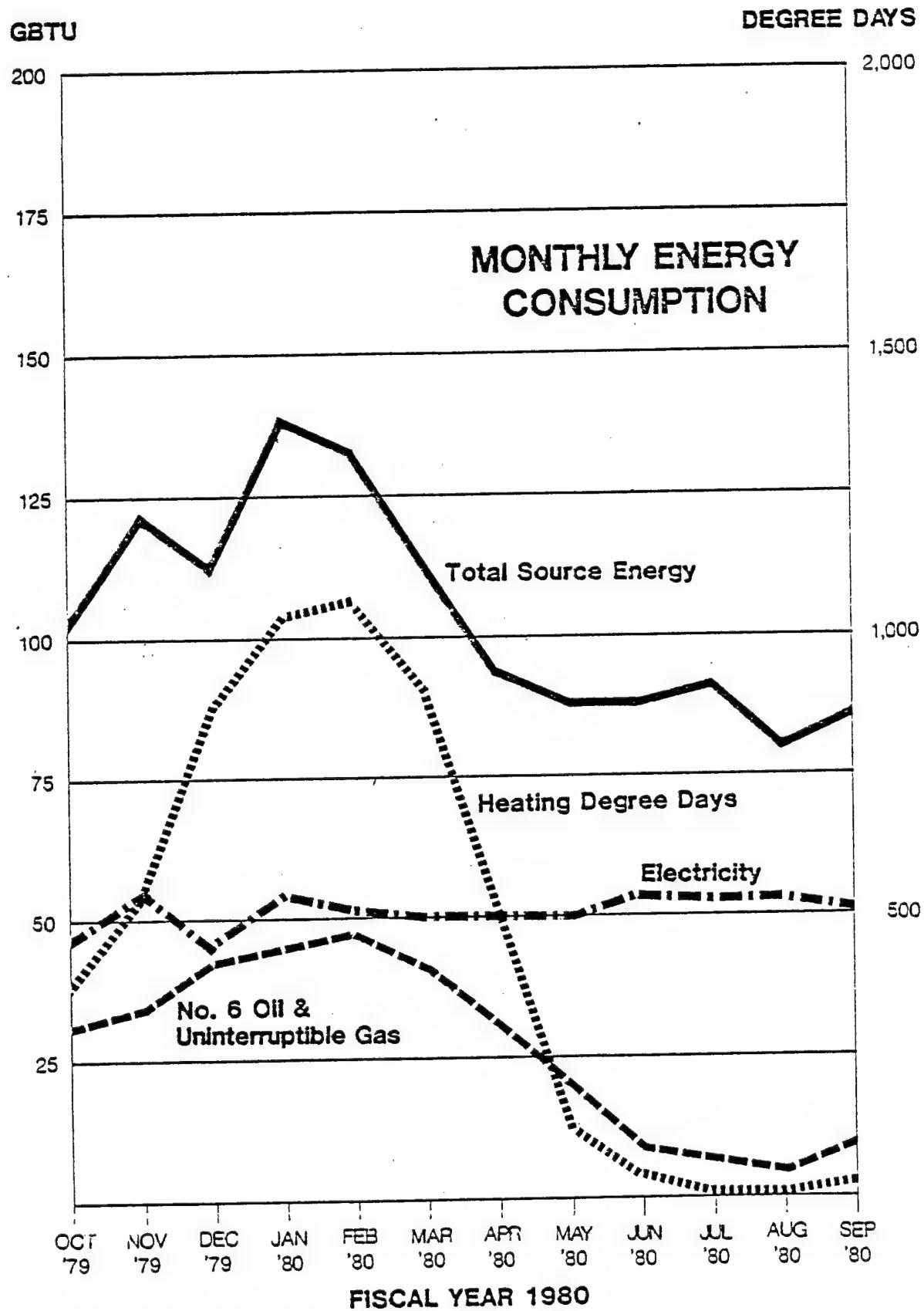


FIGURE 3 - 4

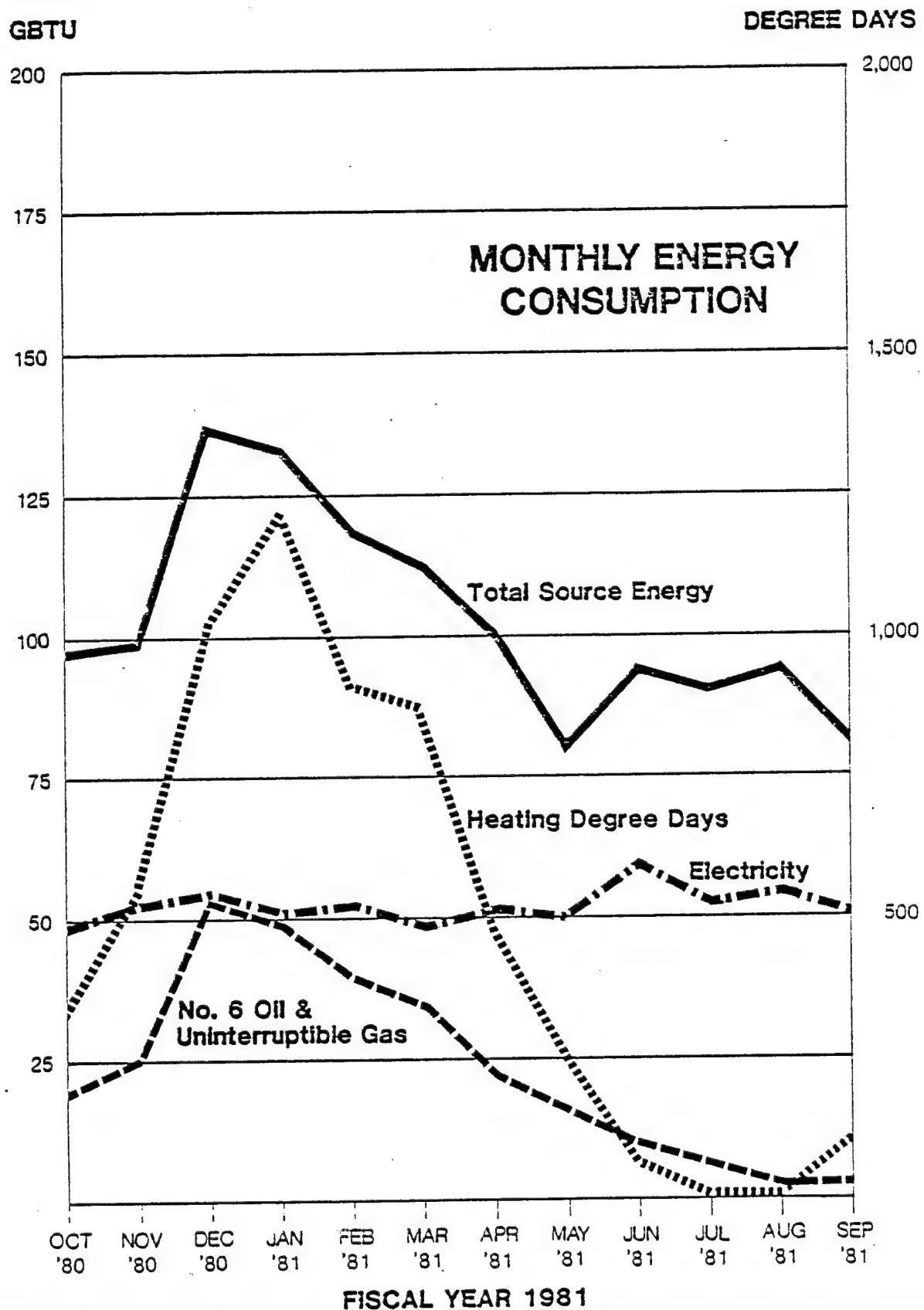
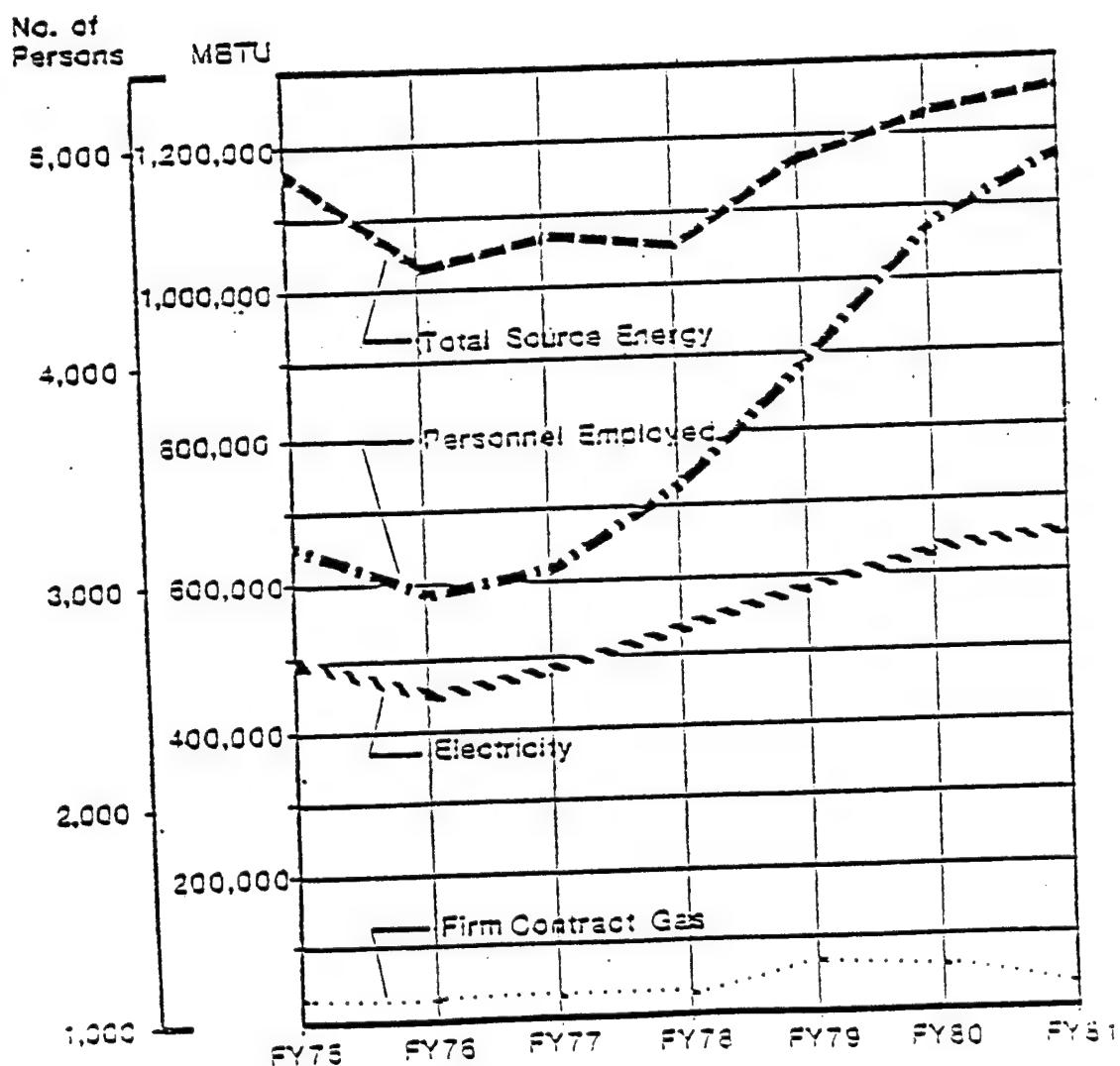


FIGURE 3 - 5

LEGEND

- Total Source Energy
- Electricity
- Personnel Employed
- Firm Contract Gas

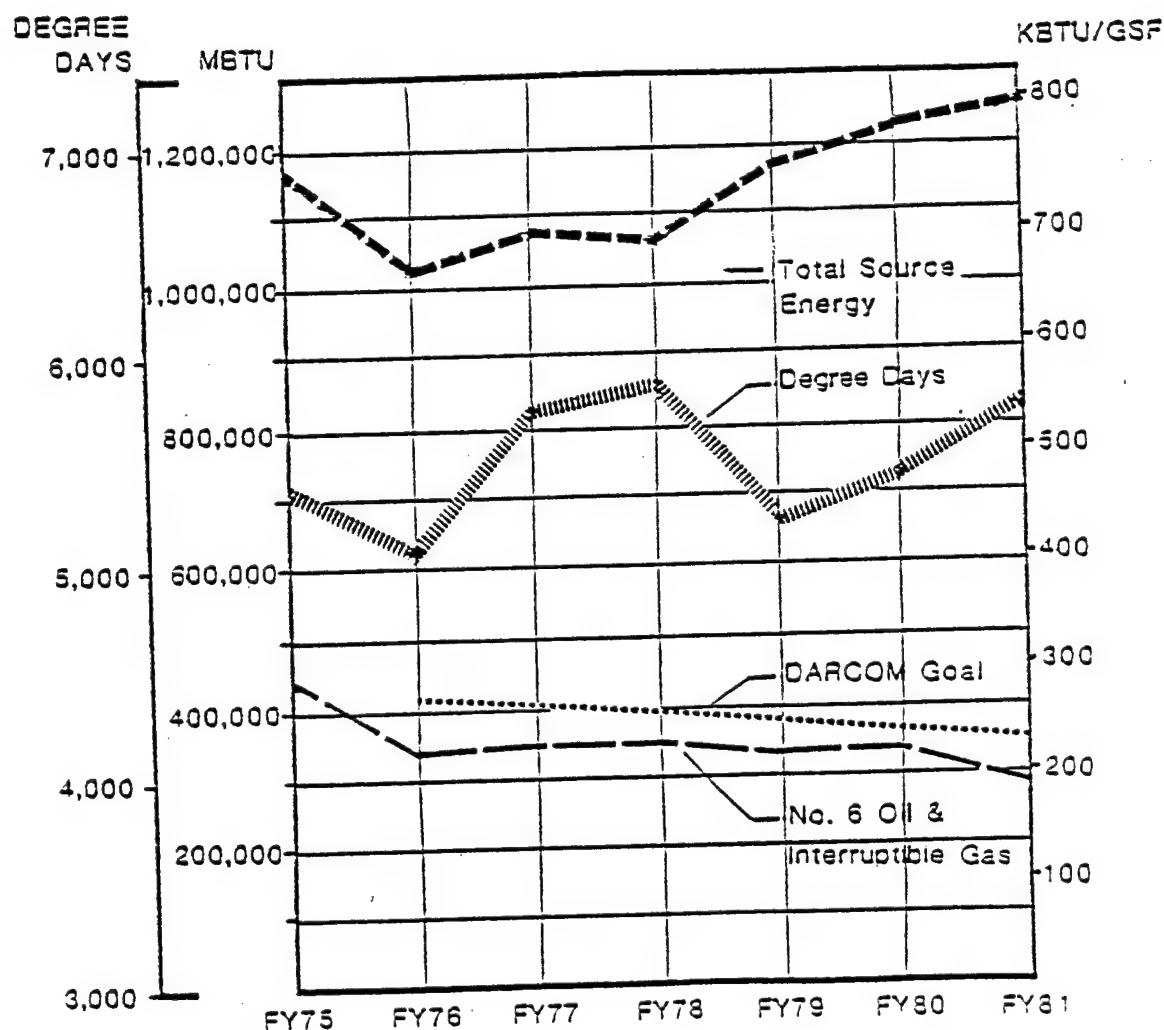


ANNUAL ENERGY CONSUMPTION
PLATE 1

FIGURE 3-6

LEGEND

- Total Source Energy
- Heating Degree Days
- DARCOM Goal
- No. 6 Oil & Interruptible Gas



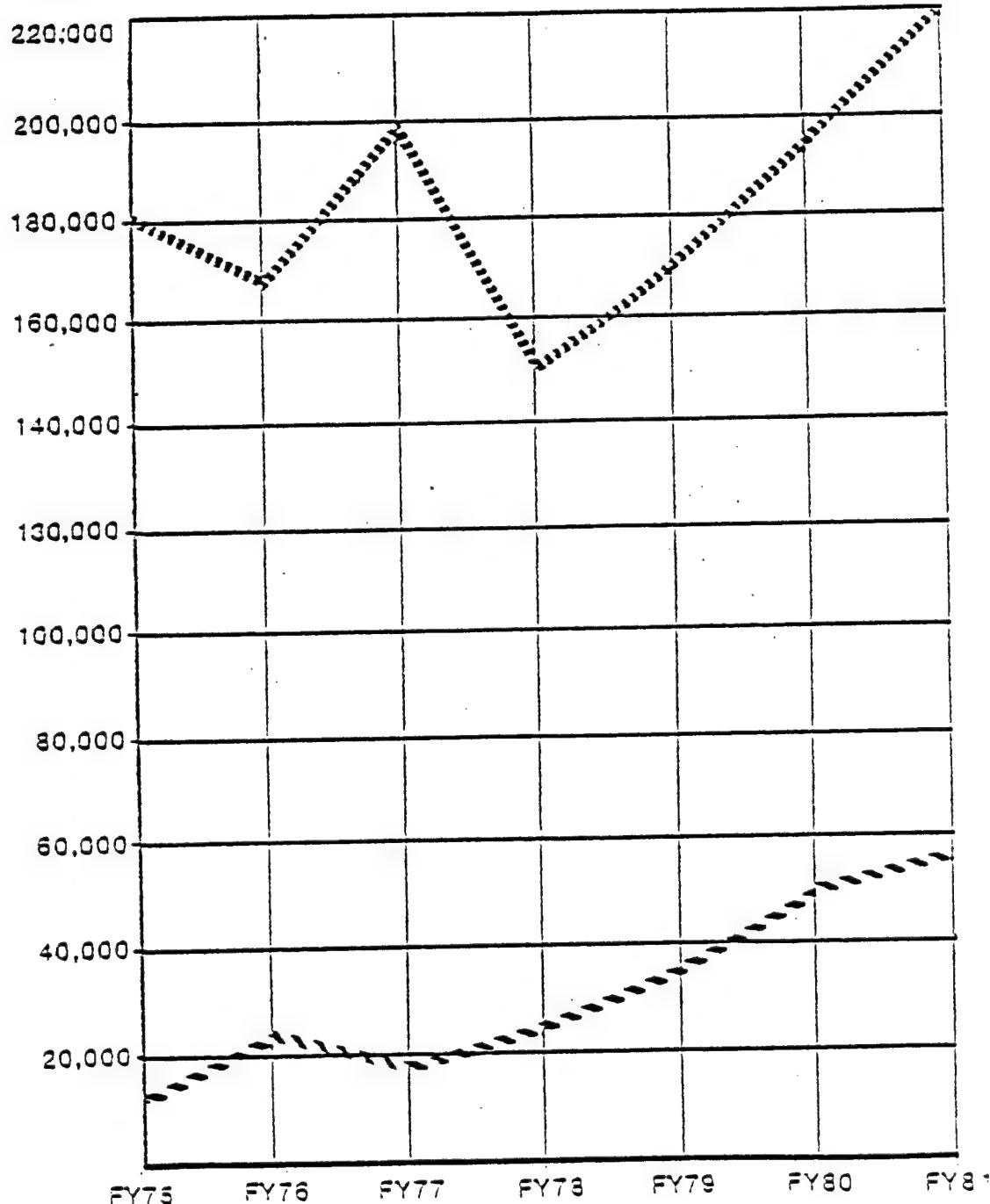
ANNUAL ENERGY CONSUMPTION
PLATE 2

LEGEND

DIESEL FUEL
JT 4 & JT 6

FIGURE 3-7

METU



JET FUEL & DIESEL FUEL
CONSUMPTION

Since the gross area remained substantially constant over the period, an additional scale on the right of both graphs allows the energy curves to be read in terms of annual consumption per unit of gross area.

All energy curves show a noticeable decline from FY 75 to FY 76. This correlates with a fall in employment, reflecting a decline in plant activity over that year.

Figure 3-7 shows diesel fuel and jet fuel consumption mainly for the record.

3.4 Central Boiler Plant - Thermal Load Profile

The central boiler plant uses No. 6 fuel oil and interruptible natural gas.

3.4.1 Tabular Information

Month by month breakdowns showing No. 6 fuel oil, interruptible natural gas, total boiler fuel (in MBTU) and percentage of yearly use are shown for FY81, FY80 and FY79 (the last three available years) in Tables 3.4.1-1, 3.4.1-2 and 3.4.1-3, respectively.

TABLE 3.4.1-1
FY81 BOILER FUEL CONSUMPTION

<u>MONTH</u>	<u>NO. 6 OIL</u>	<u>INT. GAS</u>	<u>TOT. MBTU</u>	<u>% YEARLY USE</u>
Oct. 80	0	18,531	18,531	6.2
Nov. 80	0	24,523	24,523	8.2
Dec. 80	30,481	56,757	56,757	18.9
Jan. 81	49,173	49,173	49,173	16.4
Feb. 81	38,264	0	38,264	12.7
Mar. 81	23,508	12,214	35,722	11.9
Apr. 81	0	24,333	24,333	8.1
May 81	0	13,442	13,442	4.5
June 81	0	11,614	11,614	3.9
July 81	0	9,747	9,747	3.2
Aug. 81	0	8,840	8,840	2.9
Sep. 81	0	<u>9,470</u>	<u>9,470</u>	<u>3.2</u>
Totals	141,426	158,990	300,416	100

TABLE 3.4.1-2
FY80 BOILER FUEL CONSUMPTION

<u>MONTH</u>	<u>NO. 6 OIL</u>	<u>INT. GAS</u>	<u>TOT. MBTU</u>	<u>% YEARLY USE</u>
Oct. 79	1,784	29,436	31,220	9.3
Nov. 79	0	36,545	36,545	10.9
Dec. 79	0	41,940	41,940	12.5
Jan. 80	0	49,519	49,519	14.7
Feb. 80	25,188	22,290	47,478	14.1
Mar. 80	0	43,008	43,008	12.8
Apr. 80	0	28,372	28,372	8.4
May 80	0	20,773	20,773	6.2
June 80	0	14,820	14,820	4.4
July 80	0	8,154	8,154	2.4
Aug. 80	0	4,760	4,760	1.4
Sep. 80	0	9,934	9,934	3.0
Totals	26,972	309,551	336,523	100

TABLE 3.4.1-3
FY79 BOILER FUEL CONSUMPTION

<u>MONTH</u>	<u>NO. 6 OIL</u>	<u>INT. GAS</u>	<u>TOT. MBTU</u>	<u>% YEARLY USE</u>
Oct. 78	21,684	0	21,684	6.5
Nov. 78	38,078	2	38,080	11.4
Dec. 78	48,120	0	48,120	14.4
Jan. 79	54,686	0	54,686	16.4
Feb. 79	50,672	0	50,672	15.2
Mar. 79	22,036	0	22,036	6.6
Apr. 79	~ 306	24,637	24,943	7.5
May 79	0	15,879	15,879	4.8
June 79	0	13,933	13,933	4.2
July 79	0	14,211	14,211	4.3
Aug. 79	0	12,529	12,529	3.8
Sep. 79	0	16,968	16,968	5.1
Totals	235,582	98,519	333,741	100

3.4.2 Graphic Information

Month by month boiler fuel consumption (MBTU) for FY81, FY80, FY79 is plotted in Figures 3-8, 3-9, and 3-10 respectively.

FIGURE 3-8

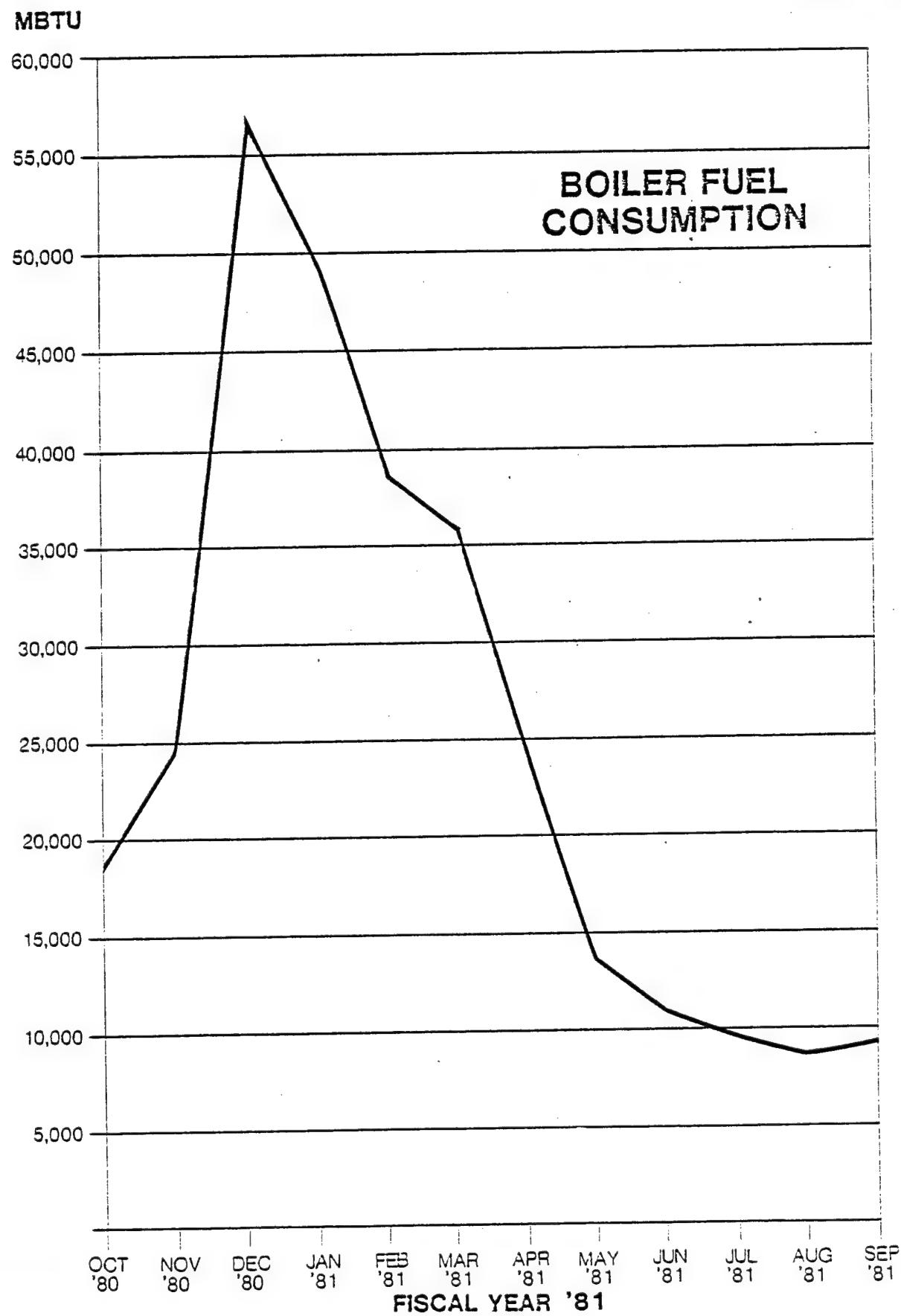


FIGURE 3-9

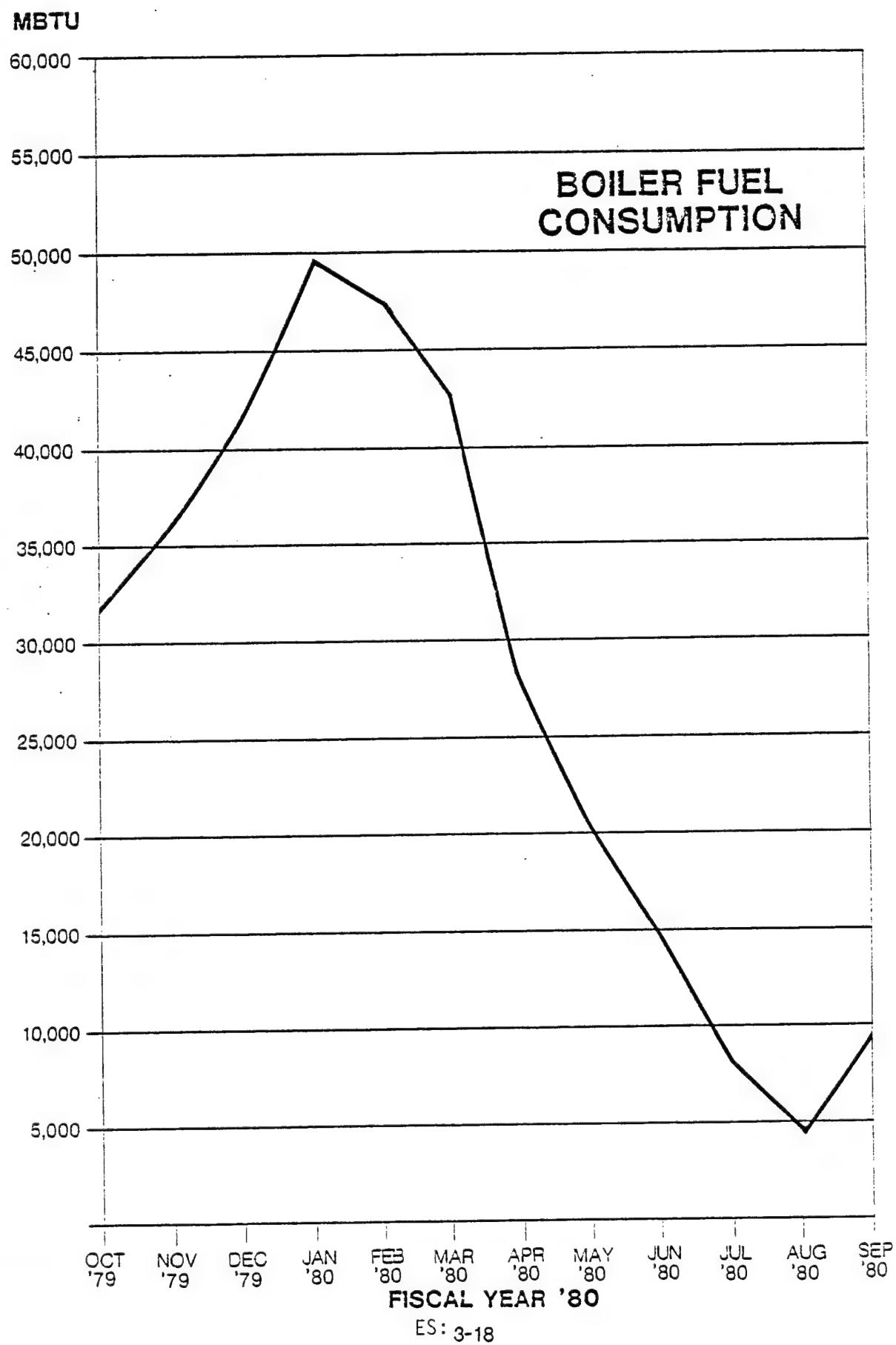
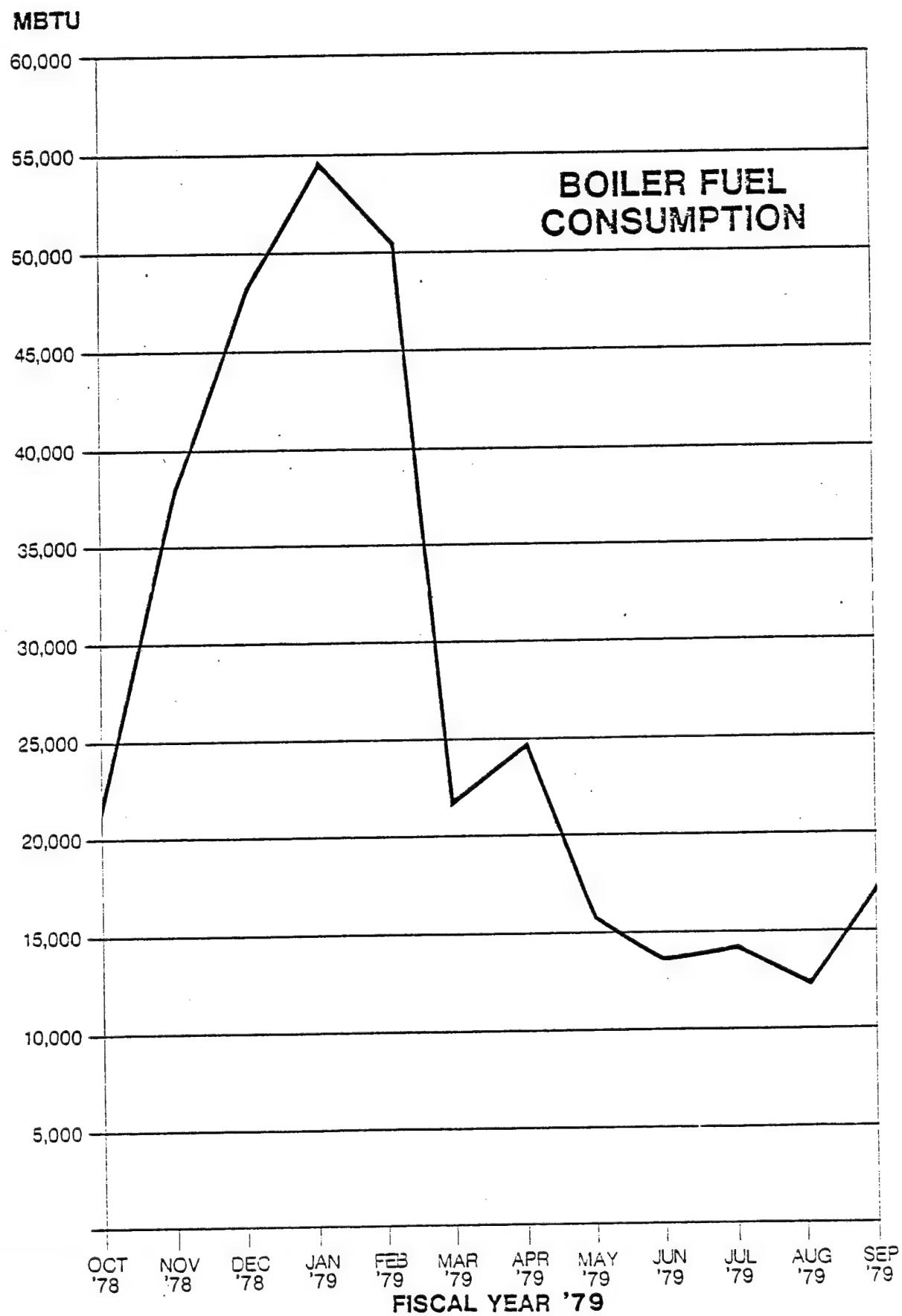


FIGURE 3-10



3.5 Energy Costs

Table 3.5 summarizes energy costs for electricity, interruptible natural gas and No. 6 fuel oil at SAEP.

Energy Costs
Table 3.5

Energy Source	Cost Per Unit FY 81	Cost Per MBTU FY 81	Cost Per MBTU Escalated To FY 84
Electricity	0.082 \$/KWH	7.07	10.76
Interruptible Natural Gas	0.043 \$/CCF	4.47	7.71
No. 6 Oil	0.87 \$/Gal	6.01	9.15

The energy costs were derived in the following manner:

- o Fuel consumption and costs for FY81 were obtained from base utility records.
- o Cost per unit of each fuel is the total yearly cost divided by the total yearly consumption.
- o Cost per MBTU (FY81) is based on the following conversion factors:

$$\begin{aligned}1 \text{ KWH} &= 0.0116 \text{ MBTU} \\1 \text{ CCF of Natural Gas} &= 0.1031 \text{ MBTU} \\1 \text{ GAL of No. 6 Oil} &= 0.144 \text{ MBTU}\end{aligned}$$

- o Cost per MBTU (FY84) is based on the following annual escalation rates:

Electricity 15%
Natural Gas 20%
Fuel Oil 15%

The annual escalation rates are obtained from the Norfolk District ECIP Criteria dated November 10, 1980 - Appendix B, Table 2.

4.0 Energy and Cost Savings

4.1 Predicted Energy Savings from Recommended Projects

Predicted energy savings from recommended ECIP projects and "in-house" projects, in MBTU/YR, are listed below in Table 4-1 for electricity, No. 6 oil, interruptible natural gas and source energy.

**TABLE 4-1
MBTU/YR ENERGY SAVINGS FROM RECOMMENDED PROJECTS**

<u>PROJECT</u>	<u>INCREMENT</u>	<u>ELEC</u>	<u>NO. 6</u>	<u>GAS</u>	<u>SOURCE</u>
Summer Boiler	E	1,720	0	9,375	11,095
Waste Oil	E	- 218	12,000	0	11,782
Wall Insul.	G*	83	5,511	6,214	11,808
Storm Windows	A	1,580	2,920	0	4,500
DHW Heaters	G*	8	2	3	13
Light Fixtures	A	576	0	0	576
Screw Chiller	G*	2,556	0	0	2,556
Anti-Strat.					
Unit Heater	A	-1,385	6,016	6,784	11,415
DHW Pipe Insul.	A	108	157	177	442
Roof Rehabilita-					
tion	In-House	0	14,500	14,500	29,000
Condensate Sys-					
tem Rehab.	In-House	0	3,150	3,150	6,300
HPS Lighting	In-House	55,000	0	0	55,000
Rehab. Bldg. 3A	In-House	0	100	0	100
Kalwall	In-House	0	3,750	3,750	7,500
Econ. Fin-Tube					
& O2 Trim	B		9,747		
TOTALS	-	60,028	57,853	43,953	161,834

*This is normally an Increment A item, but SIR is less than 1.0.

4.2 Energy Savings - Percent Reduction from Base Year FY75

Percent reduction for each individual energy source and total source energy are listed in Table 4-2 below.

**TABLE 4-2
ENERGY SAVINGS PERCENT REDUCTION
FROM BASE YEAR FY75**

<u>FUEL</u>	<u>FY75 - MBTU</u>	<u>SAVINGS - MBTU</u>	<u>% REDUCTION</u>
Elec.	496,886	60,028	12
No. 6 Oil	243,847	57,853	24
Gas	186,702	43,953	24
Source*	1,154,036	161,834	14

*Total does not add due to process related fuels such as jet fuel, diesel, firm gas, etc.

4.3 Anticipated Monetary Savings and Construction Costs

Annual dollar savings and construction costs for each of the ECIP projects are listed in Table 4-4, below.

TABLE 4-4
ANNUAL DOLLAR SAVINGS AND CONSTRUCTION COSTS

<u>PROJECT</u>	<u>\$/YR SAVED</u>	<u>CWE-84</u>
Summer Boiler	90,788	253,878
Waste Oil	88,554	840,739
Wall Insulation	116,481	2,319,000
Storm Windows	50,263	303,015
DHW Heaters	147	17,934
Light Fixtures	7,125	13,870
Screw Chiller	31,617	2,010,729
Anti-Strat Unit Heater	108,907	890,969
DHW Pipe Insulation	4,624	19,265
Econ Fintube & O2 Trim	<u>102,538</u>	<u>351,576</u>
TOTALS	601,049	7,020,975

The simple amortization for the above projects is
 $(7,020,975/601,044)$ 11.7 years. The SIR is
 $(21,231,402/7,020,975)$ 3.0.

5.0 Increment D

5.1 Scope

The purpose of Increment D is to determine the feasibility of new cogeneration and solid waste plants utilizing solid fuels, supplemented, as feasible, with refuse derived fuels (RDF) and waste oil fuels. Programming documents (DD Forms 1391 and PDBs) are required for feasible projects.

Solid waste and RDF plants are not part of this contract. Refer to Detailed Scope of Work and DACA65-81-C-0024 supplementary contract of July 82 for further details. The Scope of Work is in the Appendix-Section B.

5.2 Projects Investigated

The projects investigated under this Increment are listed in Table 5-1, below.

**TABLE 5-1
INCREMENT D-PROJECTS INVESTIGATED**

- o Cogeneration from Central Boiler Plant
- o Cogeneration/High and Low Temperature Heat Recovery From Engine Test Cells
- o Cogeneration/High Temperature Heat Recovery From Engine Test Cells

5.3 Brief Description of Projects Investigated

5.3.1 Cogeneration from Central Boiler Plant

The present central boiler plant cannot meet cogeneration requirements. The present 100 psig steam output would have to become the turbine outlet pressure in order to maintain current heating and process requirements. The turbine inlet pressure (i.e., boiler output pressure) would have to be 600 psig. In addition, the cogeneration boiler would have to utilize coal. (See Increment D definition Section 4.1.)

5.3.2 Cogeneration/High and Low Temperature Heat Recovery

Test engines fall into one of two categories: production engines or development engines. These engines are test in one of 31 test cells. Twenty-eight of these cells are located in Building 16.

Energy input to the test engines is represented by jet or diesel fuel. Energy output is transmitted along a shaft which is connected to a water brake. Losses (i.e., the difference between energy input and output) are represented by high temperature exhaust.

This subject has been studied by AVCO-LYCOMING personnel. A copy of an "in-house" report on engine test cell heat recovery has been reproduced and is in the Appendix-Section F.

5.3.3 Cogeneration/High Temperature Heat Recovery

The objective of this project is to utilize heat from test engine exhaust to supply high pressure steam to generate electricity and back-pressure steam to operate a steam absorption chiller. The absorption chiller is required to provide 800 tons of refrigeration for Bldg. 10.

5.4 Results and Conclusions

There are no recommended projects under this Increment.

6.0 Increment E

6.1 Scope

The purpose of Increment E is to determine the feasibility of installing central plants firing solid fuels serving all or discrete parts of the installation.

Stratford Army Engine Plant is currently served by a central boiler plant. When this is the case, the scope of work calls for Increment E to consist of an engineering report and economic analysis of converting the existing central plant to solid fuels (coal).

6.2 Projects Investigated

The projects investigated under this Increment are listed in Table 6-1, below.

**TABLE 6-1
INCREMENT E PROJECTS INVESTIGATED**

- o Central Boiler Plant Coal Conversion
- o Waste-Oil Burner for Central Boiler Plant
- o Single Fuel (Interruptible Natural Gas) Firetube Package Boiler for Summer Use
- o Dual Fuel (Interruptible Natural Gas and Waste Oil) Watertube Package Boiler for Summer Use

6.3 Recommended Projects

The recommended projects under this Increment are the Waste Oil Burner for the Central Boiler Plant and the Single Fuel Firetube Package Boiler for Summer Use.

6.4 Brief Description of Recommended Projects

6.4.1 Waste Oil Burner for Central Boiler Plant

SAEP generates waste oil, mainly from machine tools, at a rate of 10,000 gallons per month. With filtration, chemical treatment, and a supplementary burner this oil can be used as a boiler plant fuel. Using waste oil as a boiler fuel has several benefits:

- o SAEP currently pays \$0.30/gal to dispose of the waste oil.
- o Consumption of traditional boiler fuels (No. 6 Oil and Int. Nat. Gas) is reduced.

- o Waste Oil Recovery is a partial solution to the long range waste disposal problem at SEAP and in the rest of the Town of Stratford.

6.4.2 Single Fuel Firetube Package Boiler for Summer Use

The central boiler plant consists of 3 units @ 60,000 lbs steam/hr output. The average summer (May-September) steam demand is 10,300 lb/hr. Running the central plant at such low summer loads is extremely inefficient.

This project proposes a summer shutdown of the central boiler plant. A single fuel (Int. Nat. Gas) firetube 17,250 lb/hr (500 boiler horsepower) package boiler will be able to meet the anticipated 10,300 lb/hr summer steam demand. The basis for the energy savings is the increased efficiency at this load for the package boiler. In addition, there will be an electric energy savings due to a reduction in the electrical auxiliary loads (boiler feedwater pumps and induced draft fans).

6.5 Brief Description of Projects Considered But Not Recommended

6.5.1 Boiler Plant Coal Conversion

The primary objective of boiler plant coal conversion is to reduce dependence on petroleum fuels. An additional benefit is that coal is significantly cheaper than fuel oil (in this case \$10.52/MBTU vs \$4.07 MBTU).

6.5.2 Dual Fuel Watertube Package Boiler For Summer Use

The basic objective of this project is the same as that of the single fuel fire tube package boiler which was previously discussed in Section 5.3. Additional savings would result from the burning of waste oil which would otherwise cost \$0.30/gal to dispose of. However, this additional savings is more than offset by the cost of additional controls, piping, pumps, physical and chemical treatment and frequent cleaning of burners. In addition, 10,000 gal/mo amounts to only 550 lbs steam/hr which is 2% of the anticipated summer load. It was agreed during a field visit/meeting at SAEF on 10/21/83 to delete waste oil from the summer package boiler. When the summer boiler is in operation, waste oil will be kept in an on-site storage tank.

6.6

Economic Analysis of Recommended Projects

Recommended Increment E Projects listing MBTU/YR saved, \$/YR saved, CWE-84, SIR, ECR and SAP (Years) are listed in Table 6-2, below.

TABLE 6-2

INCREMENT E - RECOMMENDED PROJECTS

<u>DESCRIPTION</u>	<u>MBTU/YR</u>	<u>\$/YR</u>	<u>CWE-84</u>	<u>SIR</u>	<u>ECR</u>	<u>SAP</u>
Waste Oil - Cent. Plant	11,782	88,554	840,739	1.6	14.0	18.6
Firetube Pkg. Boiler	<u>11,095</u>	<u>90,788</u>	<u>253,878</u>	<u>6.3</u>	<u>43.7</u>	<u>2.8</u>
TOTAL/AVG	22,877	179,342	1,094,617	2.7	20.7	6.1

7.0 Energy Plan

7.1 Summary of Results

1. With the implementation of the recommended projects from Increments D, E, F outlined in this report, plus prior work from Increments A, B, G; source energy consumption per unit area will be reduced by 14%. This does not meet the DARCOM goal of 24%. If process fuels are eliminated from the analysis, a 23% reduction of source energy per unit area can be achieved.
2. Using a base year of FY75, there will be the following reduction in overall energy use:
 - o Electricity 12%
 - o No. 6 Oil 24%
 - o Int. Natural Gas 24%
 - o Source Energy 14%
3. The recommended ECIP projects from this analysis will result in an annual dollar savings of \$601,044, a construction cost of \$7,020,975, will have a simple amortization period of 11.7 years and a SIR OF 3.0.

7.2 Unit Energy Consumption and the DARCOM Goal

Figure 7-1, on the following page, shows actual unit consumption (KBTU/GSF-YR) from FY75 through FY81 and projected unit consumption from FY82 through FY85. The DARCOM goal is represented by a straight line from FY75 through FY85 showing a 2% reduction per year over a ten year period (an overall reduction of 20%).

Historical unit consumption from FY75 through FY81 is listed in Table 7-1, below.

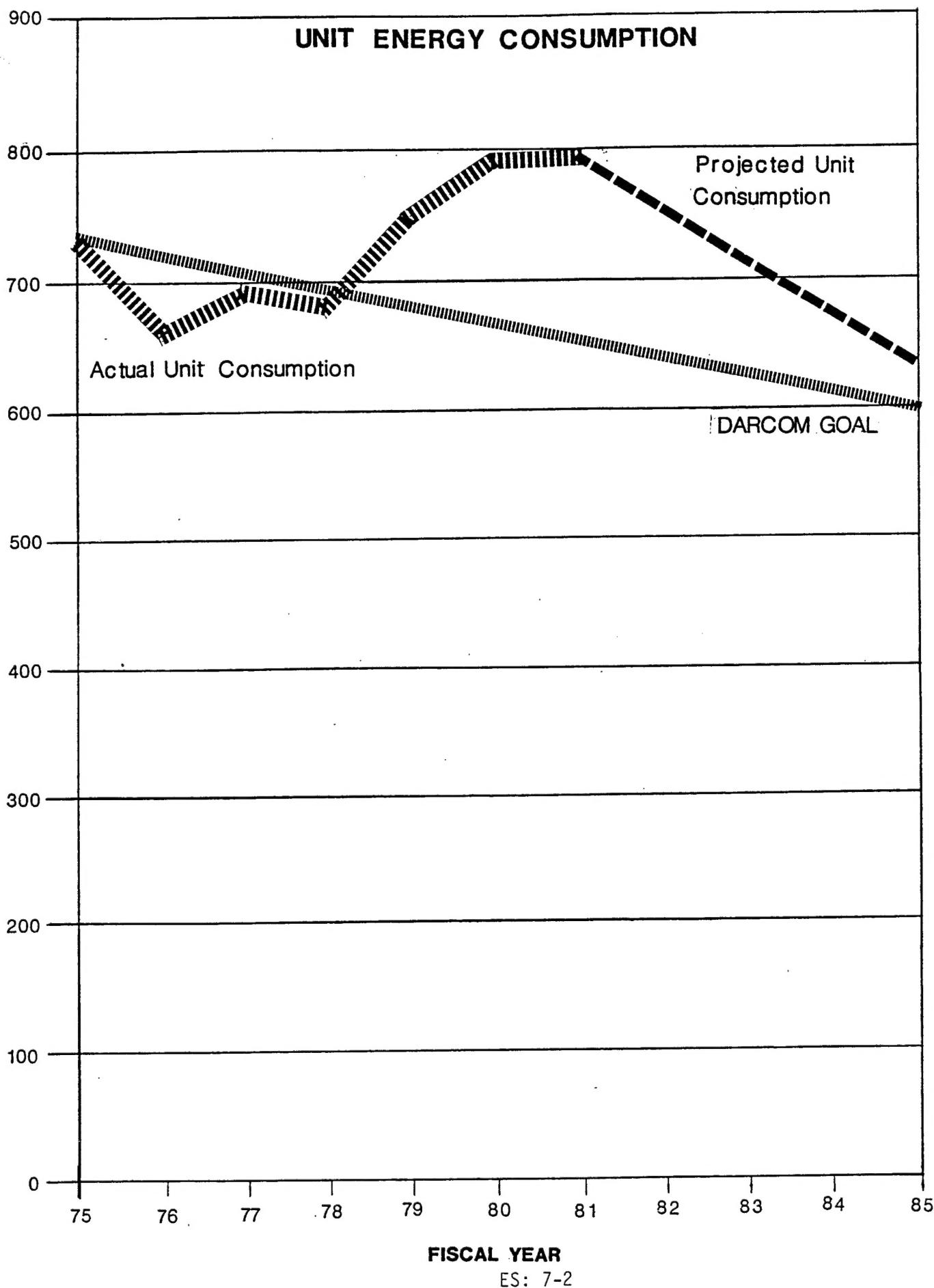
TABLE 7-1
UNIT ENERGY CONSUMPTION FY75 THROUGH FY81

<u>YEAR</u>	<u>KBTU/GSF-YR</u>
FY75	739
FY76	659
FY77	693
FY78	689
FY79	748
FY80	790
FY81	793

The unit energy consumption savings for FY85 is calculated as follows:

KBTU/GSF-YR

FIGURE 7-1



161,834 MBTU x 1,000 KBTU/MBTU + 1,560,764 SQ. FT.

= 103.7 KBTU/GSF-YR

The percent reduction is:

(103.7/739) x 100 = 14%

This does not meet the DARCOM goal (a 20% reduction from FY75 to FY85) of 147.8 KBTU/GSF-YR saved.

The simple amortization for the above projects is
(7,020,975/601,044) 11.7 years. The SIR is 3.0.

7.3 Recommended Projects

7.3.1 Increments D, E, F

Recommended projects from Increments D, E, F are outlined in Table 7-2, below.

TABLE 7-2

RECOMMENDED PROJECTS - INCREMENTS D, E, F

<u>PROJECT</u>	<u>MBTU/ YR SAVED</u>	<u>\$/YR SAVED</u>	<u>LIFE- CYCLE SAVINGS</u>	<u>CWE- 84</u>	<u>SIR</u>	<u>SAP (YRS)</u>
Summer Boiler	11,095	90,788	1,527,583	253,878	6.3	2.8
Waste Oil	11,783	88,554	1,784,663	840,739	1.6	18.6
TOTAL/AVG	22,877	179,342	3,312,246	1,094,617	2.7	6.1

7.3.2 Increments A,B,G

Recommended projects from Increments A,B,G is outlined in Table 7-3, below.

TABLE 7-3
 RECOMMENDED PROJECTS - INCREMENTS A, B, G

<u>PROJECT</u>	<u>MBTU/ YR SAVED</u>	<u>\$/YR SAVED</u>	<u>LIFE- CYCLE SAVINGS</u>	<u>CWE- 84</u>	<u>SIR</u>	<u>SAP (YRS)</u>
Storm Wind.	4,500	50,503	666,633	303,015	2.2	6.0
DHW HTRS.	13	147	1,790	17,934	0.1	122.0
Light Fix.	576	7,125	74,898	13,870	5.4	2.0
Screw Chiller	2,556	31,617	402,145	2,010,729	0.2	63.6
Unit Heaters	11,415	108,907	1,603,745	890,969	1.8	8.2
Pipe Insul.	442	4,624	59,720	19,265	3.1	4.2
Ecom & O2 Trim	<u>9,747</u>	<u>102,538</u>	<u>1,687,565</u>	<u>351,576</u>	<u>4.8</u>	<u>3.4</u>
TOTAL/AVG.	29,249	305,461	4,496,496	3,496,496	1.4	10.0